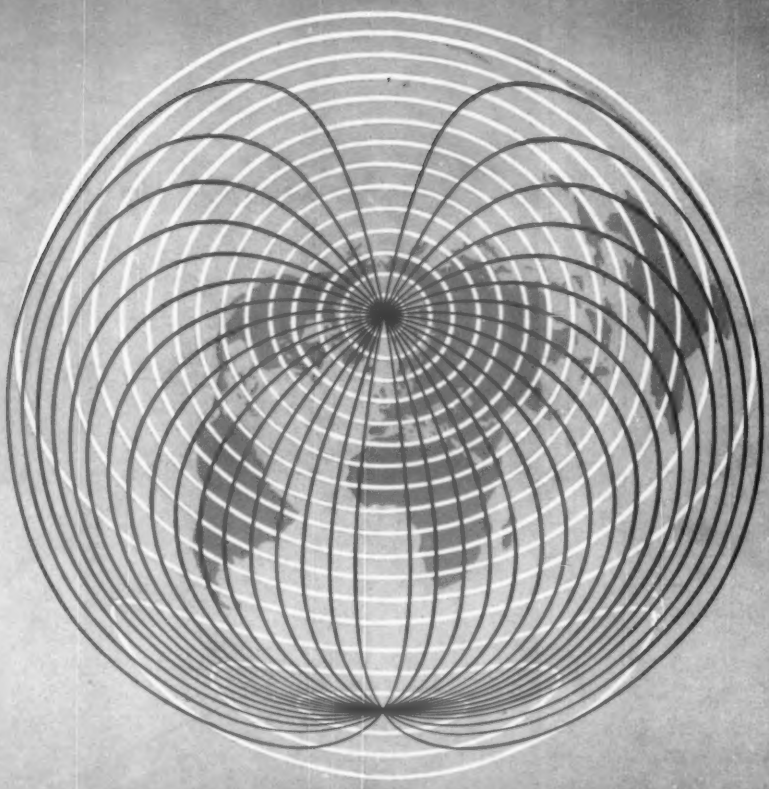
Wireless World

JULY 1951 · TWO SHILLINGS



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Scale sub-divisions provide more than adequate discrimination for use in television circuits. Note the starred features below, which combine to maintain a minimum signal of less than 1μV up to 20 Mc/s. and less than 3μV between 20 Mc/s. and 80 Mc/s.

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Co-axial socket for attenuated output. Force socket located totally within H.F. compartment.

2 **MAINS TRANSFORMER**
Marked tagboard for inputs of 100–130V. and 200–260V., A.C. 50/60 c/s.

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Standard types run at a rating to ensure long life.

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Employs close tolerance, high stability midget carbon resistors, low reactance rotary potentiometer modified for H.F. operation with carefully designed screening.

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ILLUMINATED SPOT RANGE SELECTOR
Gives rapid identification of operational band with intensified lighting round precise frequency. Fine hair line gives close discrimination, particularly on high frequencies.

STOPS
Separate stops prevent turning of dial with respect to condenser.

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provide additional rigidity for rotary controls.

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S.G.2
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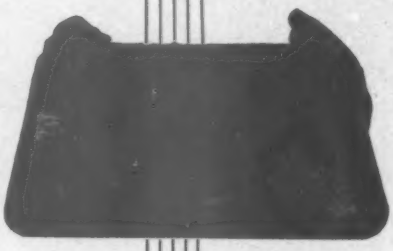

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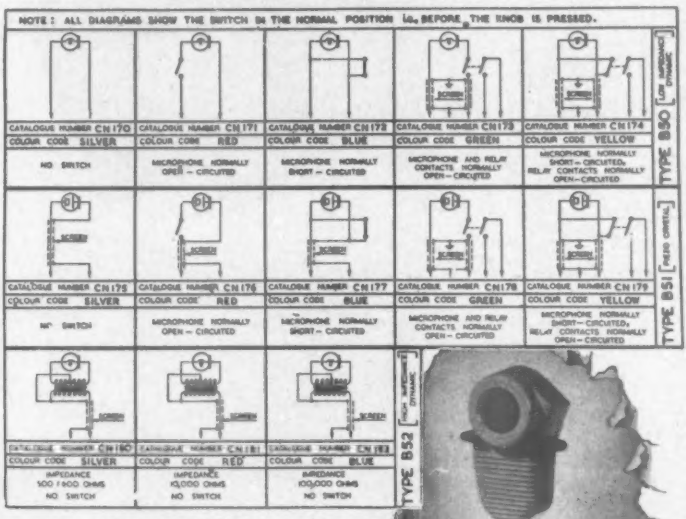
NOTE: ALL DIAGRAMS SHOW THE SWITCH IN THE NORMAL POSITION i.e., BEFORE THE KNOB IS PRESSED.
TYPE B50 (Low impedance moving coil)
CATALOGUE NUMBER CN170
COLOUR CODE SILVER
NO SWITCH
CATALOGUE NUMBER CN171
COLOUR CODE RED
MICROPHONE NORMALLY OPEN – CIRCUITED
CATALOGUE NUMBER CN172
COLOUR CODE BLUE
MICROPHONE NORMALLY SHORT – CIRCUITED
CATALOGUE NUMBER CN173
COLOUR CODE GREEN
MICROPHONE AND RELAY CONTACTS NORMALLY OPEN – CIRCUITED
CATALOGUE NUMBER CN174
COLOUR CODE YELLOW
MICROPHONE NORMALLY SHORT – CIRCUITED, RELAY CONTACTS NORMALLY OPEN – CIRCUITED
TYPE B51 (Piezo crystal)
CATALOGUE NUMBER CN175
COLOUR CODE SILVER
NO SWITCH
CATALOGUE NUMBER CN176
COLOUR CODE RED
MICROPHONE NORMALLY OPEN – CIRCUITED
CATALOGUE NUMBER CN177
COLOUR CODE BLUE
MICROPHONE NORMALLY SHORT – CIRCUITED
CATALOGUE NUMBER CN178
COLOUR CODE GREEN
MICROPHONE AND RELAY CONTACTS NORMALLY OPEN – CIRCUITED
CATALOGUE NUMBER CN179
COLOUR CODE YELLOW
MICROPHONE NORMALLY SHORT – CIRCUITED, RELAY CONTACTS NORMALLY OPEN – CIRCUITED
TYPE B52 (Low impedance dynamic)
CATALOGUE NUMBER CN180
COLOUR CODE SILVER
IMPEDANCE 100 / 600 OHMS
NO SWITCH
CATALOGUE NUMBER CN181
COLOUR CODE RED
IMPEDANCE 10,000 OHMS
NO SWITCH
CATALOGUE NUMBER CN182
COLOUR CODE BLUE
IMPEDANCE 100,000 OHMS
NO SWITCH

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Cables: Vitavox, London, England.

VITAVOX *microphones*

Relevant Facts

on B.50 Series Microphones

The VITAVOX B.50 Series is most comprehensive and includes instruments to meet almost every requirement for a hand microphone. The series comprises Type B.50, incorporating a high-grade moving coil element; Type B.51 with crystal insert; and Type B.52, similar to Type B.50 but with a transformer for direct connection to amplifier or medium impedance line. The diagram indicates the wide range of switch circuits available with Types B.50 and B.51, and the different transformer ratios available with Type B.52 which has no switch. Additional versions can be supplied for special purposes when required in quantity.

5586

A new MINIATURE Voltage Reference Tube

Designers of compact industrial equipments will welcome this new Mullard Miniature Voltage Reference Tube. Built on the small B7G base, it is characterised by high stability and robust construction. It should prove of great value where an extremely accurate and reliable performance, coupled with a maximum saving of space, is required. The larger version of this tube known as the 85A1 built on a B8G loctal base is also freely available.

Working in a constant current circuit, these tubes provide a voltage source of extremely high constancy, and in the majority of applications may be used to replace a standard cell as a built-in source of voltage reference. They may likewise be used as a reference against which to compare or fix the level of almost any physical quantity which is convertible into an e.m.f. Their use in this manner in position control systems, temperature control devices, etc., will thus be apparent.

VALVE DATA	
Nominal Operating Voltage	85V
Max Starting Voltage	125V
Current Range	1-10mA
Preferred Operating Current	6mA
Internal Resistance at 6mA	300Ω

Mullard

THERMIONIC VALVES AND ELECTRON TUBES

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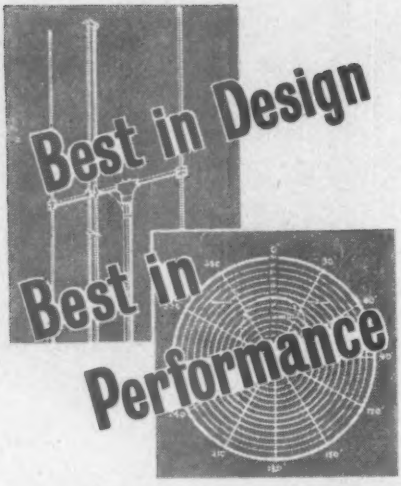
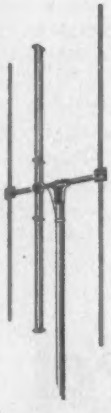


CLEAR PICTURES
in "poor reception" areas

The models 63 and 63A have been designed for maximum performance in fringe and difficult reception areas. Since the reception of your TV receiver is wholly dependent on the efficiency of the aerial system, the Aerialite features of greater gain, broader bandwidth and sharper directivity are very worthwhile. There is every reason why you should specify Aerialite for your TV aerial if you wish to ensure strong, clear and interference-free pictures. The models 63 and 63A are priced at £11.15.0 and £12.5.0 respectively, complete with 10ft. masts, lashings, etc. Models with 14ft. masts are available at 17/- extra. Aerialite are manufacturers of a comprehensive range of TV and radio aerial as well as coaxial and R.F. cables.



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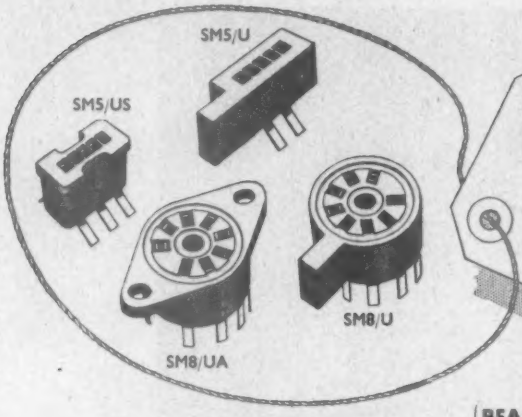

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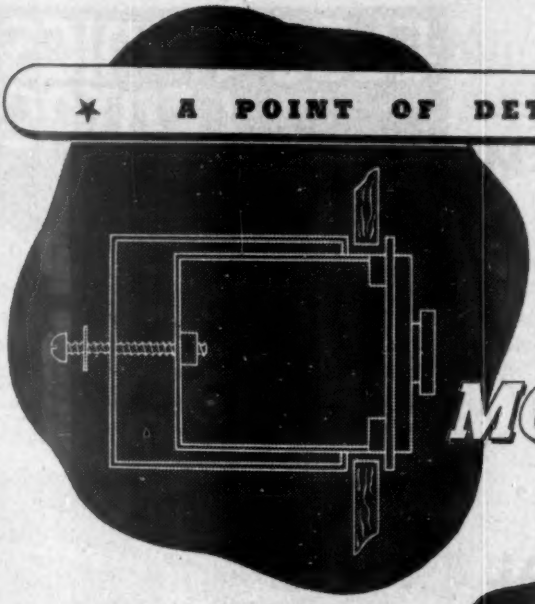
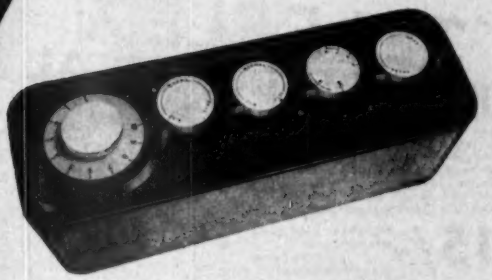
Telegrams: Oidarion, Westcent, London

★ A POINT OF DETAIL NO. 4 ★



MOUNTING



IT is logical that an amplifier of excellent electronic design should also reflect similar attention to detail in its mechanical design.

A typical example in the Q.U.A.D. amplifier is the method of mounting the control unit on a panel or in a cabinet. A cut-out is made in the panel or cabinet, half an inch smaller than the control panel dimensions (templet provided). The back cover of the control unit is removed and the unit inserted into the cut-out from the front. Projecting lugs on the back of the panel casting locate the control panel symmetrically over the cut-out. The cover is now replaced from the back and the cover retaining screws bolt the complete unit firmly in position. The panel or cabinet may be any thickness from ¼in. up to 1in.

No screws or other methods of fixing are visible from the front—no edge finishing problems are involved—the cabinet or panel is securely fastened over the whole perimeter—*all desirable features of good design.*

THE ACOUSTICAL Q.U.A.D. AMPLIFIER

An amplifier capable of providing the closest approach to the original sound yet achieved. Write for the Q.U.A.D. booklet for full detailed specifications.

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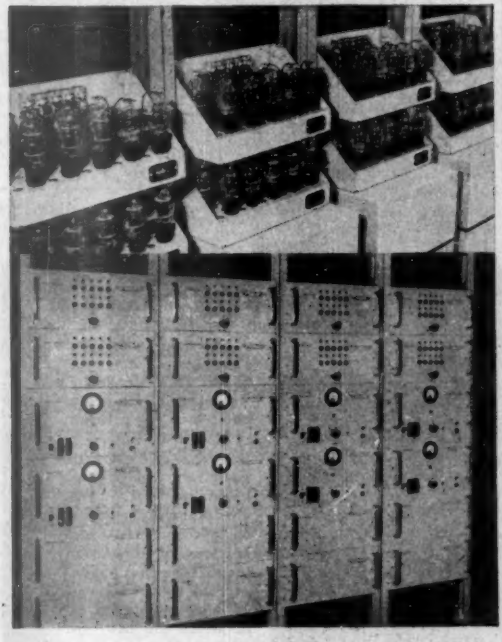
A typical example of the use of Ediswan Mazda 12E1 valves is illustrated in these photographs of a standard rack-mounted unit as supplied by All-Power Transformers, Ltd., for Government Communication and G.P.O. use. These units supply a stabilised D.C. output up to 5 amps. The Ediswan Mazda 12E1 is an indirectly heated Beam Tetrode designed for use as a series or shunt control valve in stabilised power packs.



RATING

Heater Voltage (volts)	V_h	6.3
Heater Current (amps.)	I_h	1.6
Maximum Anode Voltage (volts)	$V_{a(max.)}$	800
Maximum Screen Voltage (volts)	$V_{g2(max.)}$	300
Maximum Control Grid Voltage	$V_{g1(max.)}$	—100
Maximum Voltage between g1 and g2 (volts)	V_{g1-g2}	400
Mutual Conductance (mA/V)	g_m	* 14
Maximum Anode Dissipation (watts)	p_a	35
Maximum Screen Dissipation (watts)	p_{g2}	5.0
Maximum Cathode Current (mA)	$I_{k(max.)}$	300
Maximum Potential Heater/Cathode (volts DC)	$V_{h-k(max.)}$	†300

* Taken at $V_a = Vg2 = 150_V$ $I_a = 200$ mA.
† Provided the cathode is positive.
Base — International Octal.

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E.V. 20

MULLARD GENERAL PURPOSE OSCILLOGRAPH TYPE E805

THIS cathode ray oscillograph is for general purposes. But it incorporates many features not normally found in such instruments.

It covers a very wide range of frequency, including the whole frequency spectrum used in television. And it's equally well suited for research work, production testing or transmission monitoring. Many of Industry's high frequency problems can be solved with this oscillograph's aid — particularly those problems of motor-car ignition, flash-over on insulators, discharge at high voltages, etc.

- 3½" cathode ray tube with 1,250 volt final anode potential.
- Beam modulation. External blanking of beam for timing purposes and eliminating retrace.
- Beam suppression prevents "fogging" of film when camera shutter is open.
- Single stroke operation for non-recurrent phenomena or photographic recording.
- Calibrated step-type input attenuator with coarse and fine adjustment.

The Mullard cathode ray oscillograph, type E.805. Dimensions: Height 14"; Width 9"; Length 15½". Please write for detailed information.

SPECIFICATION

Amplifier. Gain 1,400 or 5mV rms/cm. Frequency range 2 c/s-2 mc/s. 3 dB loss.

Attenuator. Stepped 5-10-20-35 mV cm. Multiplier x 1, x 10, x 100, x 1000. Maximum input 250 V. rms.

Time Base. 5 c/s-150 Kc/s in 10 steps with continuous variation between steps.

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ULTRA GEN
No. 2

BANDWIDTH WITHOUT BOTHER

To obtain good speech and music reproduction from a super-heterodyne radio receiver a wide and level I.F. pass band is required. Selectivity is also necessary. These two requirements are conflicting.

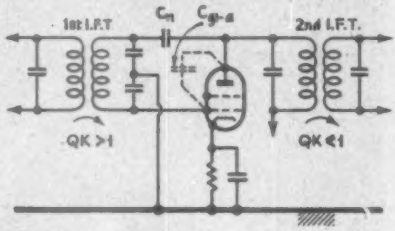
In popular priced receivers it is usual practice to keep the I.F. transformer coupling factors less than critical ($QK \leq 1$). This has the advantage that I.F. alignment is simply a peaking procedure carried out at one frequency, but the higher audio frequencies are lost (Fig. 2c). Attempts are often made to "restore" them in the A.F. stage which may be one reason why it is usual to fit a "tone control."

Briefly the trouble is the Miller effect in the I.F. amplifier valve (positive feedback through C_{g1-a}) which produces asymmetrical peaks (Fig. 2a) in the response of an overcoupled I.F. transformer in the grid circuit. Most of the difficulties of alignment are associated with compensating for this asymmetry by staggering the circuits to slightly differing frequencies.

Our Engineers have overcome the problem by a simple circuit in which C_{g1-a} is neutralized (C_n in fig. 1). The unwanted feedback is eliminated, thus allowing a symmetrical response to be obtained easily. By this means we have been able to gain the advantage of the tone quality associated with wide band response without sacrificing either selectivity or simplicity of alignment in modestly priced receivers.

This new circuit is incorporated in the new Ultra "Leader 51" and Ultragram. You will no doubt be interested in listening to them.

FIG. 1.



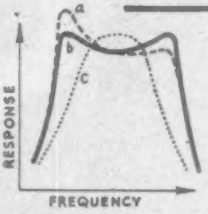


FIG. 2.

Typical Response Curves for 1st I.F.T.
a = QK>1 response
b = QK>1 neutralized response
c = QK≤1 response

ULTRA ELECTRIC LIMITED
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350 D.C.	0.001	to 0.003	A
	0.004	to 0.01	B
500 D.C.	2.5pF	to 0.001	A
	0.002	to 0.004	B
300 A.C.	0.00025	to 0.001	A
	0.002	to 0.004	B

★A. 3/16" x 7/16" B. 1/4" x 9/16"

● *Capacitances up to 1 uF 350V. D.C. wkg. and 2 uF 250V. D.C. wkg. are also available in Miniature Moldseal Metallised Paper Tubulars. Type W48*

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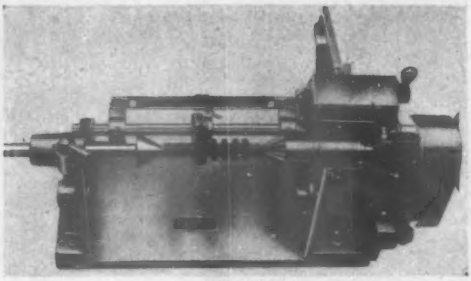

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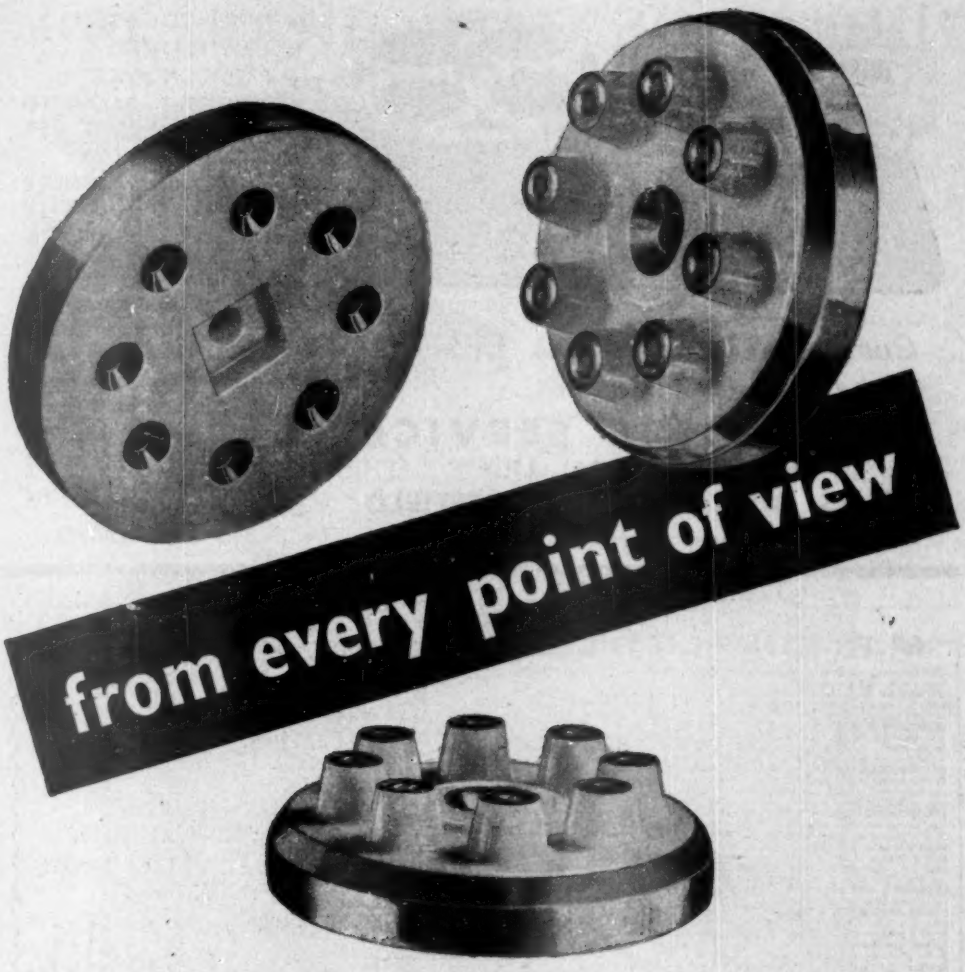

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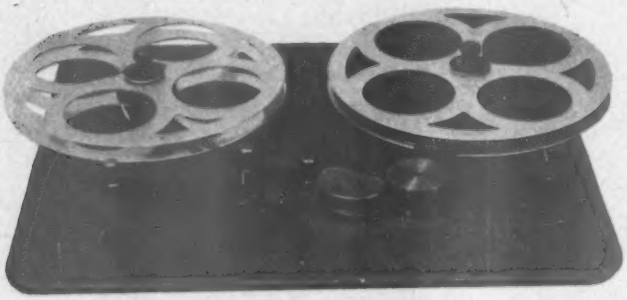

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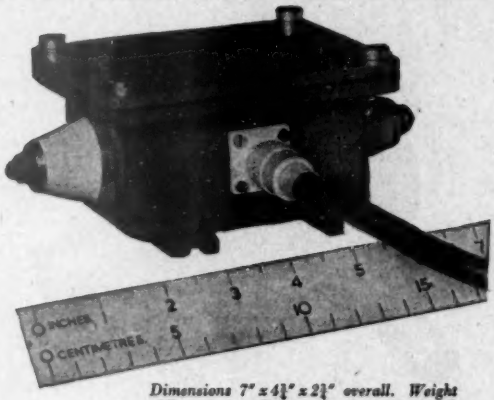

Dimensions 7" x 4¼" x 2¼" overall. Weight 4½lb. approx. Construction complies with climatic and weather-proof requirements of the relevant Inter-Service specifications.

The "A.T.M." wide band matching unit is designed to meet the need for matching different impedances over an extensive frequency range. The type shown here is for matching a 600-ohm balanced open-wire feeder from a receiving aerial to a 75-ohm unbalanced coaxial cable. Alternative types can be provided for matching other impedance values, either balanced or unbalanced according to individual requirements. The units are compact and light in weight.

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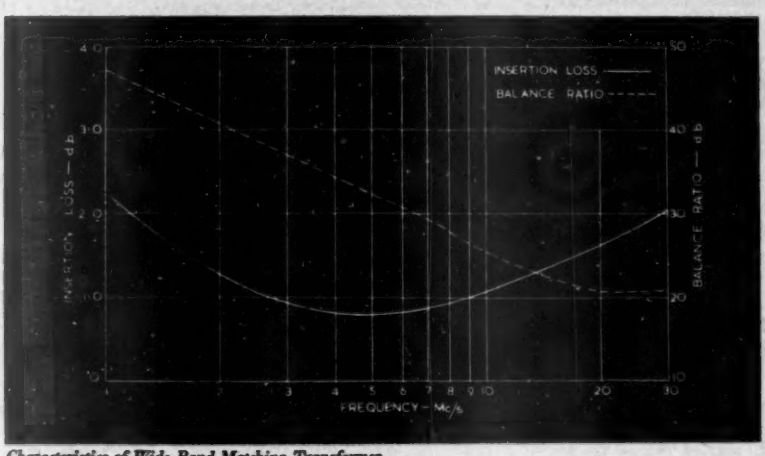

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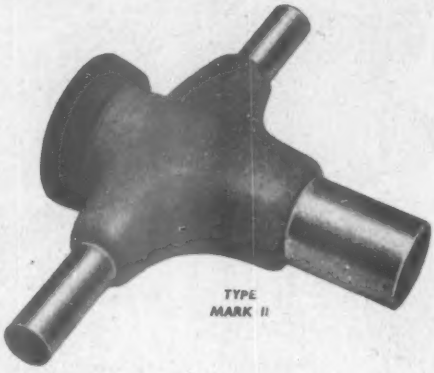

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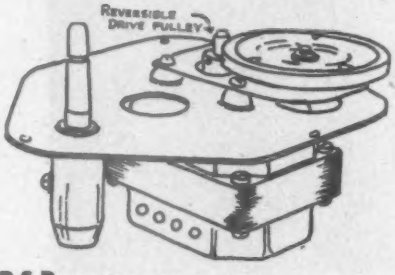

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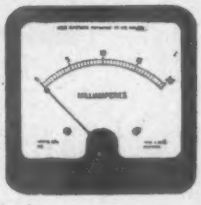

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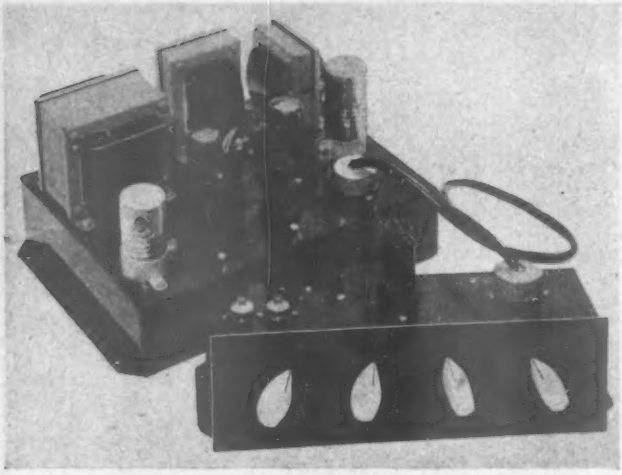

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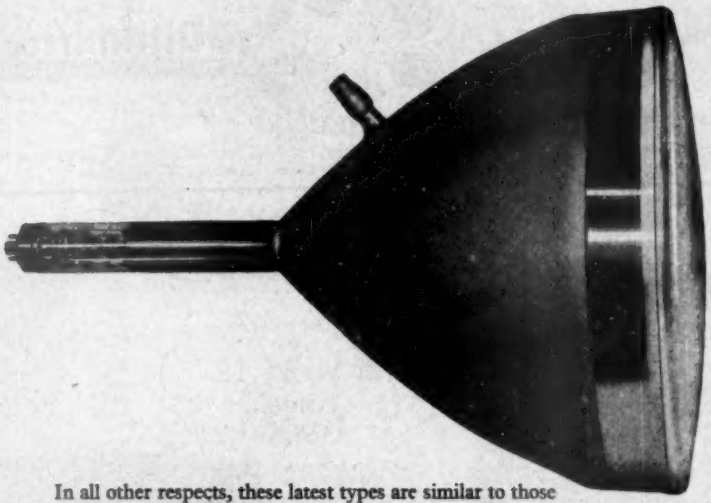

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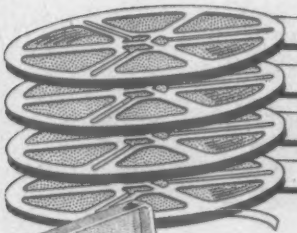

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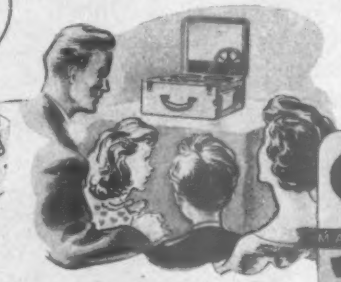

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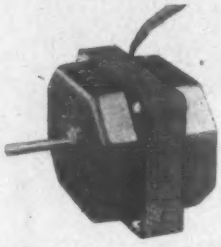

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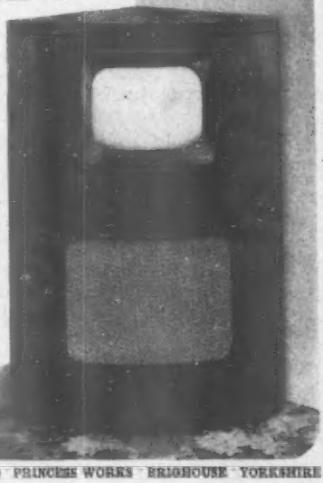

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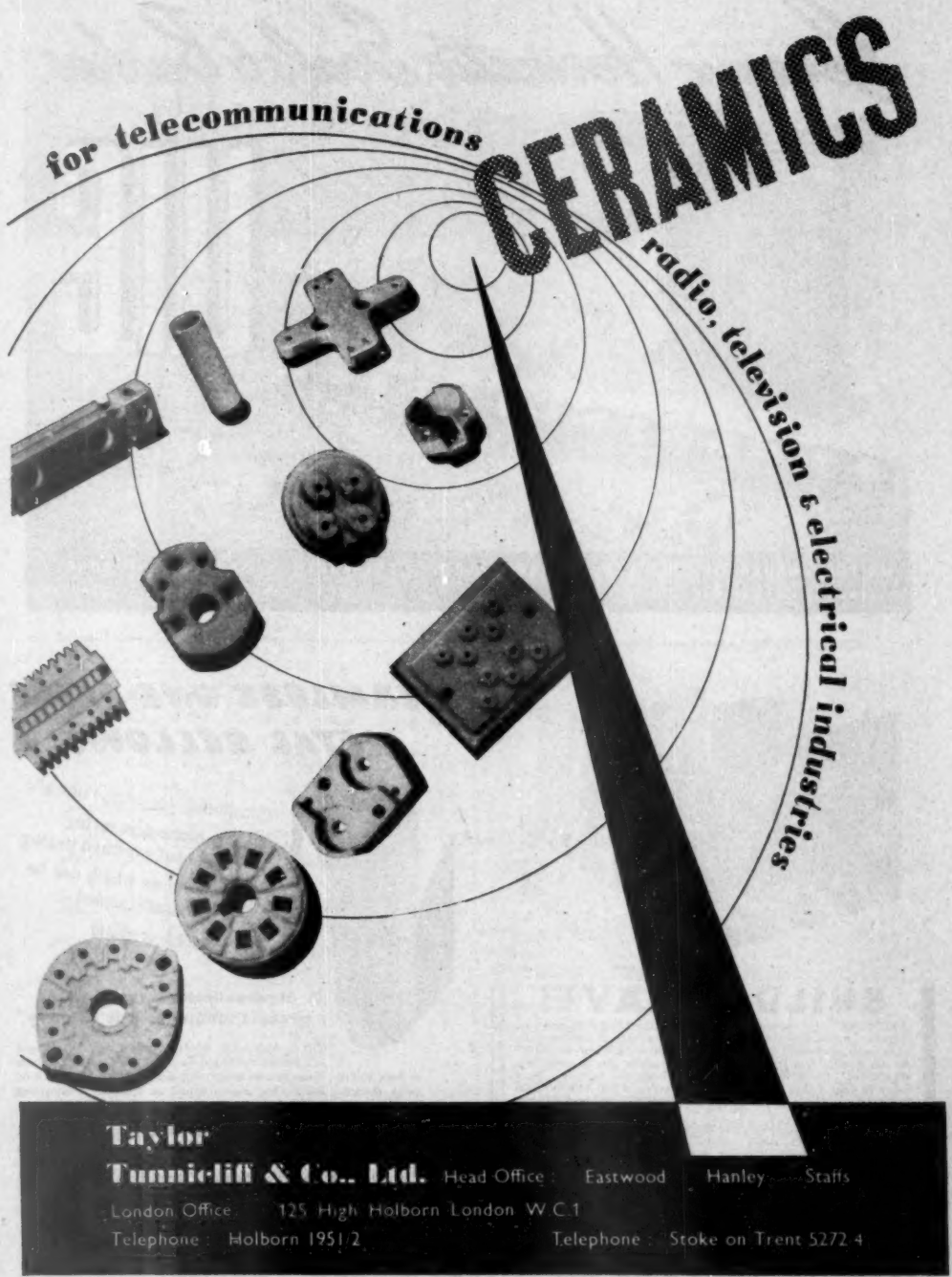

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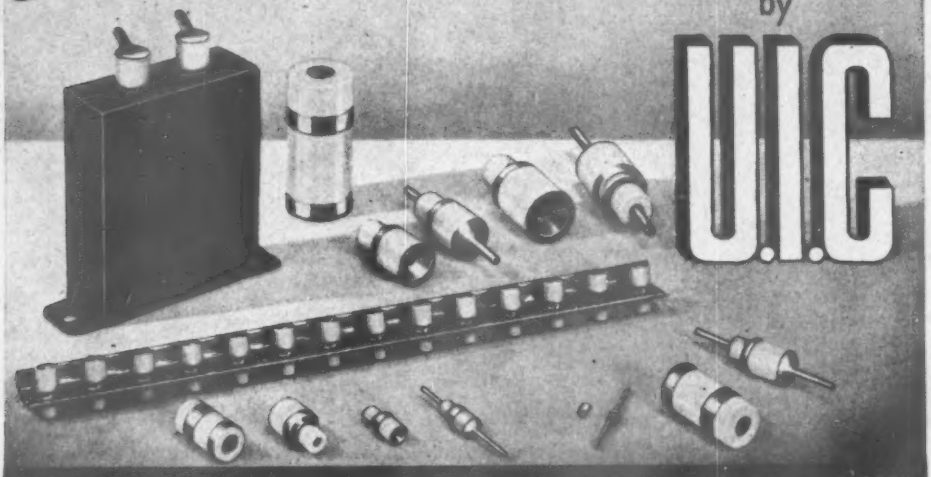

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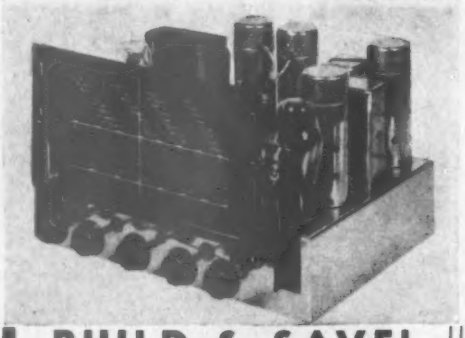

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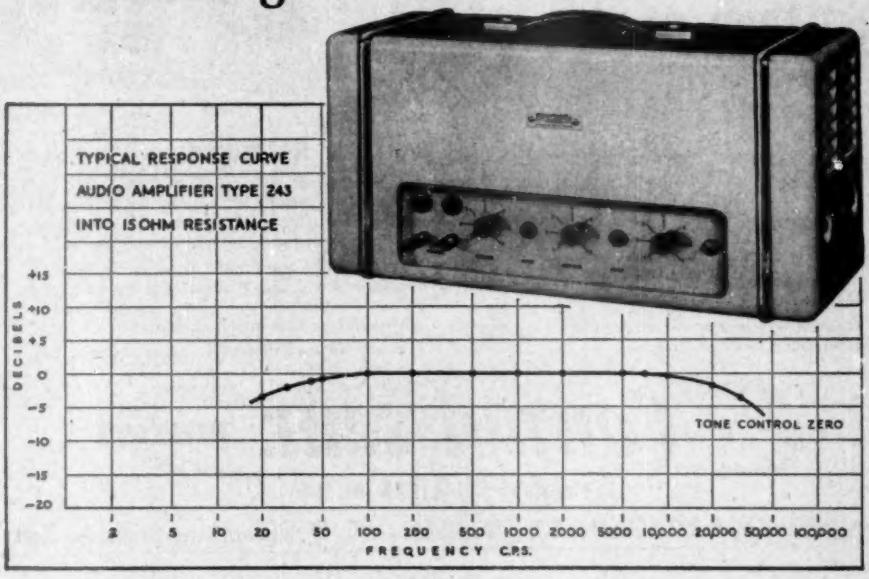

The METROVICK audio amplifier

TYPE 243

The type 243 amplifier is designed for use with high grade public address systems, for the connoisseur of quality and for industrial applications where faithful response over the audio range from 30 to 15,000 cycles is required. This Metrovick instrument is outstanding in its class and provides an output of 20 watts.

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Supply: 200/250V 50 c/s single-phase; consumption approximately 270 VA for full output.

Input: Gramophone not exceeding 0.2V for full output. Microphone not exceeding 0.02V for full output. The two circuits can be mixed as required.

Impedance: 7 ohms, 15 ohms and 45 ohms.

Output: 20 watts with negligible distortion.

Tone Control: Continuously variable.

Response: ± 1 db from 30 to 15,000 c/s at zero position of tone control.

Controls: These are recessed to avoid damage and are illuminated when in operation.

Dimensions: 18½"×8½"×12½".

Weight: 66lb. net.

Finish: The instrument is housed in an attractive steel case, stove enamelled in cream or blue as desired. A leather carrying handle is fitted.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, TRAFFORD PARK, MANCHESTER, 17

Member of the A.E.I. group of companies.

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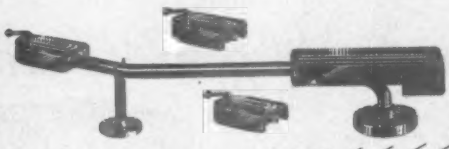
R/E 202

Three heads are better than one!



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Green Spot with .001" radius sapphire for microgroove recordings.

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These pickup heads are fitted with an easily replaceable armature system complete with a semi-permanent sapphire. Armature mass 20 mg.

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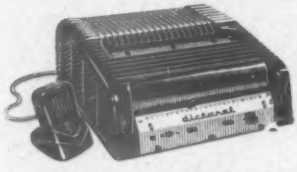

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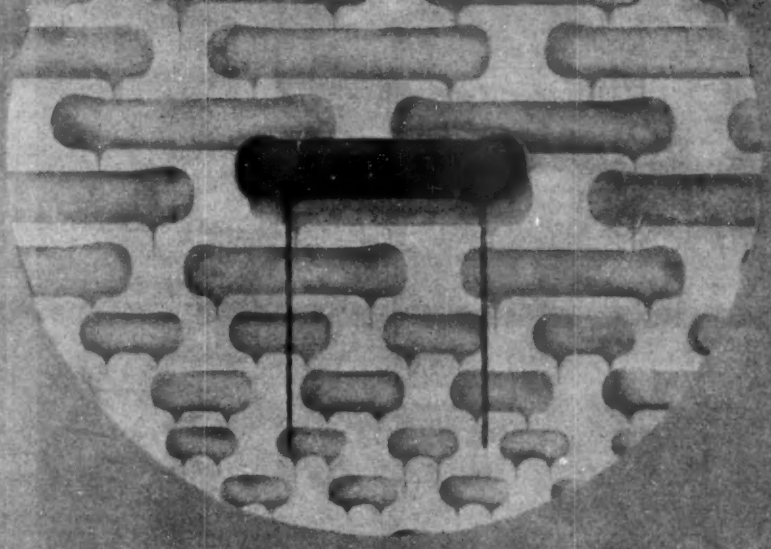

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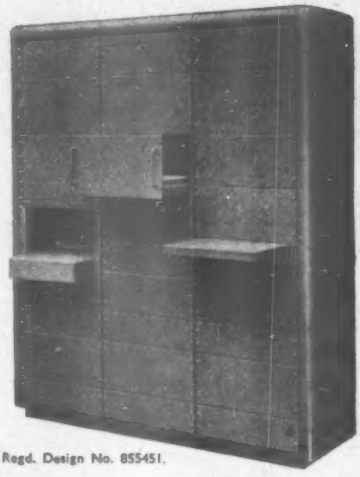

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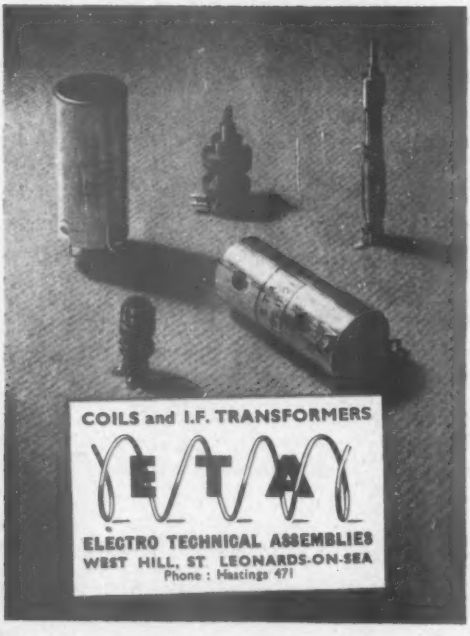

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After years of steady research, Tannoy had the privilege of installing one of the most comprehensive sound re-inforcement systems in the World, in the new House of Commons Chamber, Church, House Westminster equipment for the new United Nations Building in New York, and NOW the House of Lords.

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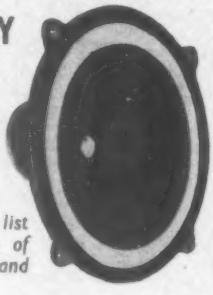

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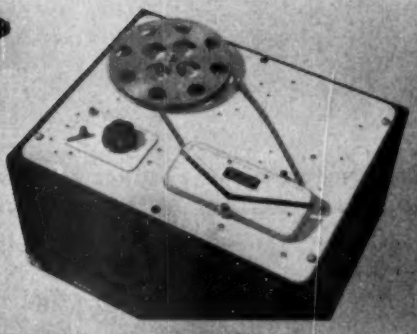
◀ The Ferrograph, combining operational simplicity with fidelity, is universally acknowledged an outstanding magnetic tape recorder of British design and manufacture. Among its users are numbered educational establishments, broadcasting studios, scientific and research organisations as well as a host of discerning music-lovers to whom quality recording and reproduction are first essentials.



Ferrograph, Series "L"—Utilising a modified Wearite "Tape-Deck," the Ferrograph Model L.67 provides a continuous-playing loop giving up to 4 minutes at 7½" per second or 8 minutes at 3¾" per second with top responses of 10,000 cycles and 5,000 cycles respectively. It has been introduced to meet the needs of such applications as announcements, rehearsals, background music and effects or indeed, any position where the requirement is continuous repetition or repetition at stated intervals. ▶

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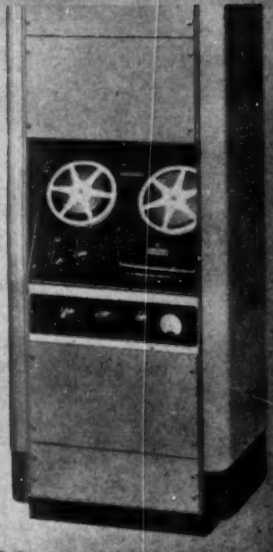

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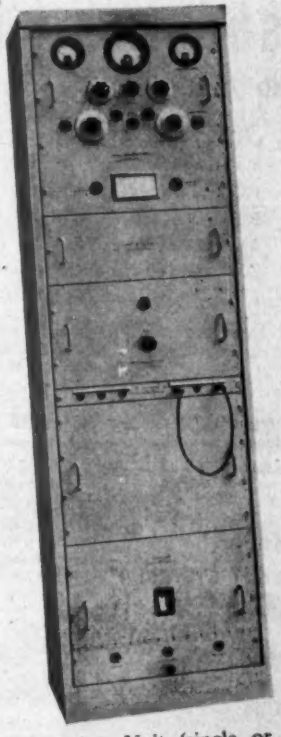

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Type OA 118c

One of the more specialised examples of our Communications equipment, the Transmission Monitor takes care of important overseeing duties in the maintenance of transmitter performance. Noise level, harmonic content and modulation depth require regular checking for consistent transmission quality, and in addition to performing these checks this equipment provides constant modulation monitoring during normal transmission. The individual units which make up the Transmission Monitor are adapted to the specific requirements of the user.

TRANSMISSION MONITOR OA118C covers wavebands 12 - 100 metres or 190 - 1650 metres. Direct-calibrated instruments read Noise Level in db., percentage Distortion and Modulation percentage; an Over-Modulation warning light is incorporated. The main components comprise Modulation Measuring Unit incorporating peak modulation monitor and noise and distortion measuring circuit; a Filter Unit (single or six-frequency); single or six-frequency Oscillator Unit for test-modulating the transmitter giving a high purity waveform output with variable output control; and a Power Unit supplying from a.c. mains both Oscillator and Modulation Measuring units. Aerial terminating unit, connection panel and jack panel are embodied in the standard equipment.

MARCONI INSTRUMENTS LTD., St. Albans, Herts. Telephone: St. Albans 6161/7

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Wharfedale

SUPER 5 LOUDSPEAKER

A highly efficient Treble Speaker . . .

with small bakelised cone for wide diffusion and high-flux magnet for wide response.

Effective cone diameter 3½".
Flux density 13,000 lines.
Aluminium speech coil 10 ohms or 3 ohms.
Die-cast chassis. Cloth suspension.
Effective range 3,000 to 20,000 c/s.

Small open Baffle, Veneered Walnut, Oak or Mahogany, available at . . 50/-
Crossover unit 3,000 c/s fitted tags at 45/-

price **£4-12-6**

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Where a two-speaker system with crossover network at 1,000 c/s is already in use, the Super 5 may be mounted in parallel with the existing treble unit, or a ·5 mfd. condenser could be inserted in series with the speech coil of the Super 5. If the H.F. output is then too strong, the two treble units may be used in series instead of in parallel.

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Widney-DORLEC

REGISTERED TRADE MARK

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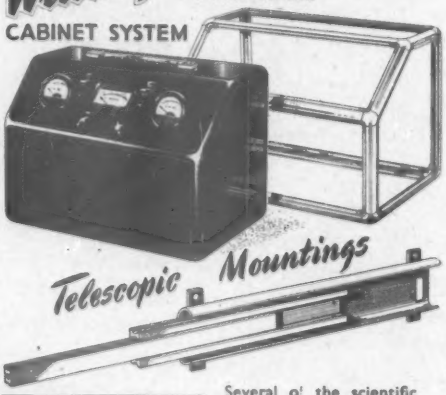

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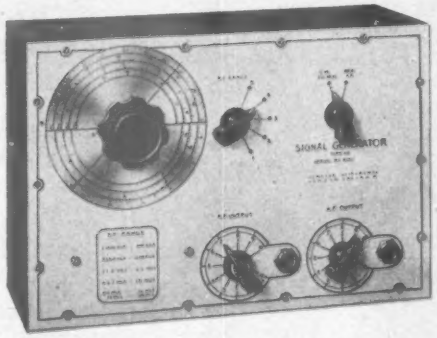

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Price £7 . 10 . 0

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Armature resonance	16 kc/s	9 kc/s
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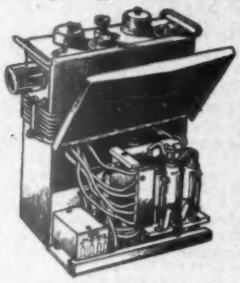

three XH and one XP Hivac midget valves. Can be adapted for Deaf Aid or Midget Receiver, but we do not supply information on this point. Batteries required 3 v. L.T., 97 v. H.T. In metal case, size 5½ × 7 × 2in. Weight 4lb., less batteries. Carr and packing 2/6. **45/-**
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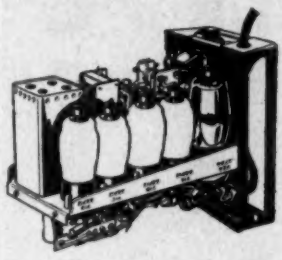

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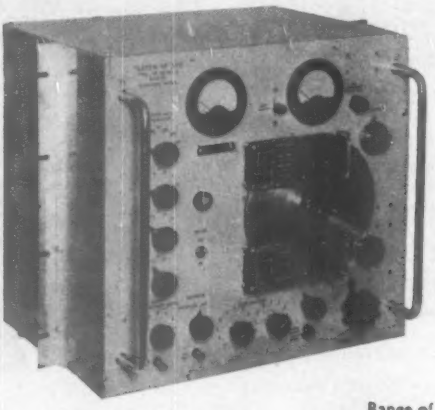

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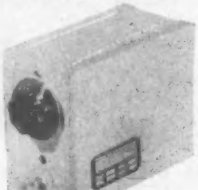

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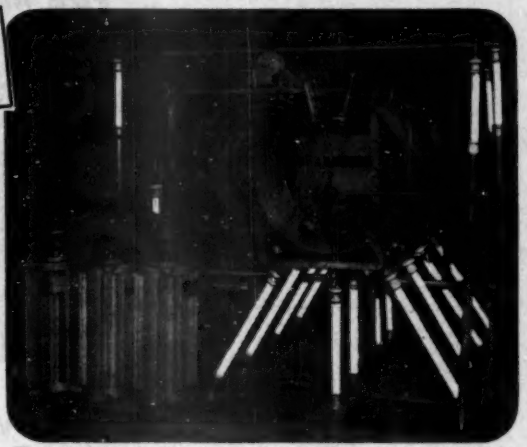

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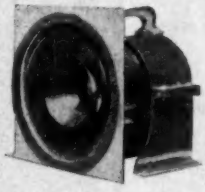

The P.M.4 is senior to our P.M.2 but does not replace it. Release date early September, price approximately £45.

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With cases T.U5, 23/6 each, plus 2/- carriage. T.U7/8/9/10 and 26B with cases, 12/6 each, plus 2/- carriage.

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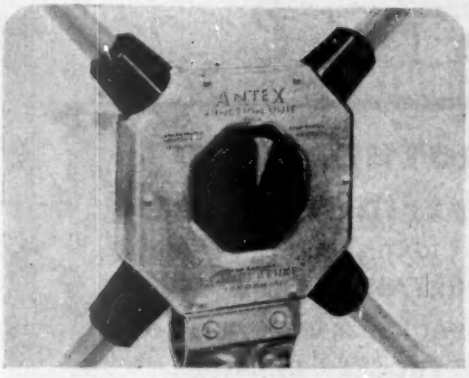

The FOUR ALTERNATIVE MOUNTINGS

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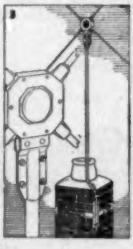

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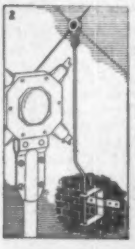

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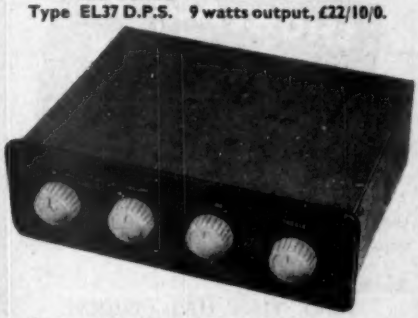

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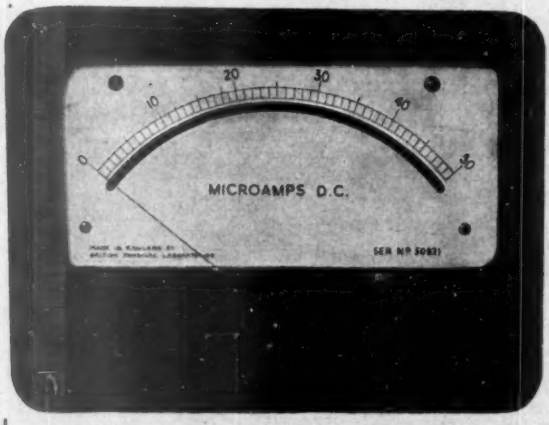

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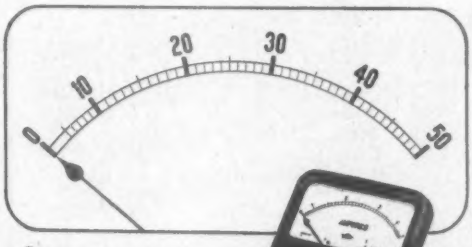

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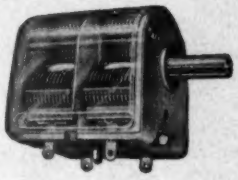

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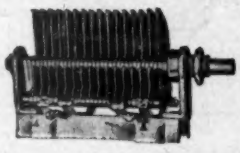

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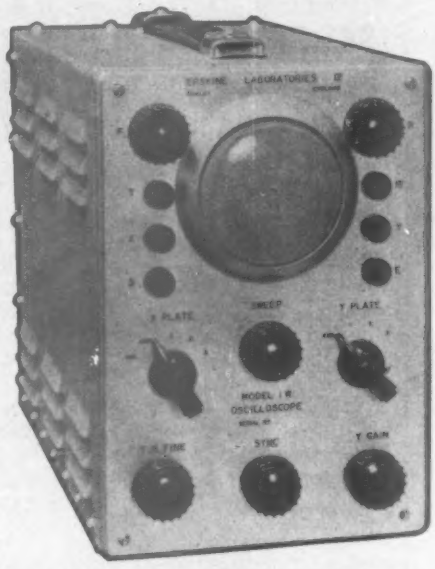

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41st YEAR OF PUBLICATION

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JULY 1951

In This Issue

EDITORIAL COMMENT 251
LOUDSPEAKER DIAPHRAGM CONTROL. By *J. Moir* .. 252
INTERMODULATION DISTORTION IN GRAMOPHONE PICKUPS By *S. Kelly* 256
B.S.R.A. ANNUAL CONVENTION 260
STANDARDIZED CHASSIS 261
HELICAL AERIAL 262
LETTERS TO THE EDITOR 263
DEVELOPMENTS IN SOUND REPRODUCTION 265
WORLD OF WIRELESS 268
FREQUENCY MODULATION—3. By "*Cathode Ray*" .. 271
RADIO ASTRONOMY 275
WROTHAM AERIAL SYSTEM—2. By *C. Gillam* 279
RECORDING ON TAPE. By *R. W. Lowden* 283
UNIVERSAL METER SHUNT 285
FURTHER NOTES ON THE *WIRELESS WORLD* TELEVISION RECEIVER 286
SHORT-WAVE CONDITIONS. By *T. W. Bennington* 288
APPROACH TO "HIGH FIDELITY" 289
NEW AMERICAN WALKIE-TALKIE 291
GAS DISCHARGE TUBES 293
TEMPERATURE FUSES 295
MANUFACTURERS' PRODUCTS 296
RANDOM RADIATIONS. By "*Diallist*" 298
UNBIASED. By "*Free Grid*" 300

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MINIATURE BATTERY RANGE

THE FILAMENT CIRCUIT IN A.B.C. RECEIVERS

The normal A.B.C. receiver will employ the following valve complement: DK91 frequency changer; DF91 I.F. amplifier; DAF91 detector and A.F. amplifier; DL94 output valve. The usual sequence of the series filament chain will be DK91—DAF91—DF91—DL94, or DAF91—DK91—DF91—DL94, in either case the DL94 being at the positive end of the chain.

Grid Bias for Output Valve

For battery operation, the voltage drop across the filaments of the first three valves then provides a bias of 4.5 V for the DL94, and any further bias required is obtained by including a resistor in the negative lead of the H.T. battery.

For mains operation, the design centre of the voltage drop across the filaments of the first three valves is 3 x 1.3 V = 3.9 V only. The balance of the required bias for the output valve is supplied by a resistor in series with the filaments and located at the negative end of the chain. This resistance is shorted out when the receiver is switched for battery operation.

Filament Shunting Resistors

It was explained in a previous article that shunt resistors must be provided for individual filaments because the cathode current of each valve flows to the filament and is non-uniformly distributed along the filament. In practical operation the current at the positive end of the filament is less than the average current in the filament by an amount equal to one-third of the cathode current, and the current at the negative end is greater than the average current in the filament by an amount equal to two-thirds of the cathode current. This means, in practice, that the filaments of all the valves, with the exception of the more positive filament limb of the output valve, must be shunted by resistors to maintain the voltage drop across each filament at 1.3 V per limb.

Calculation of the values of the various shunt resistors must, of course, be based upon the cathode current distribution indicated above, but involves only a simple application of Ohm's Law.

DIODE-PENTODE DAF91

The DAF91 comprises a short-grid-base pentode primarily designed as an A.F. voltage amplifier, combined with a single diode suitable for use as speech detector. The valve is of miniature construction on the B7G 7-pin all-glass base.

RATINGS AND CHARACTERISTICS

Filament

This valve is suitable for D.C. operation only.

V_f	1.4 V
I_f	0.05 A

Capacitances

(Measured without external shield)

C_{a-g1}	0.2 μμF
C_{in}	2.2 μμF
C_{out}	2.4 μμF

Characteristics

V_a	67.5	90	V
V_{g2}	67.5	90	V
V_{g1}	0	0	V
I_a	1.6	2.7	mA
I_{g2}	0.4	0.5	mA
g_m	625	720	μA/V
r_a	0.6	0.5	MΩ

Diode Section

The diode anode is located at the negative end of the filament.

Limiting Values

V_a max.	90 V
V_{g2} max.	90 V
V_{g1} max.	0 V
I_k max.	4.5 mA

Other valves in this range include:—

DK91 Heptode frequency changer
DF91 Variable-mu pentode
DL94 Output pentode

Reprints of this article together with additional data may be obtained free of charge from the address below.

Mullard

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MVM167

Wireless World

JULY 1951 VOL. LVII. No. 7.

Sound Reproduction

THIS issue of *Wireless World* is devoted largely to the subject of sound reproduction—an expression which we use to cover all artificial methods of reproducing, reinforcing or recording natural sounds. Extra pages have been devoted to articles on various aspects of the subject; unfortunately, it is impossible to deal with all of them. Of all the offshoots of radio, sound reproduction is probably the largest and most diverse. In some directions it has broken away almost entirely from the radio (and, going back farther, wire telephony) techniques on which it is so largely based, but in many respects the relationship is still close.

Among the many branches of electricity, electroacoustics is unique in that it has attracted a large band of fervent devotees. The reasons for this are not far to seek: as a contributor points out elsewhere in this issue, the quest for perfect reproduction amounts to chasing the unattainable, and so offers a constant stimulus to human instincts. Again, art enters into it quite as much as science; that, perhaps, is why professionals in other branches become amateurs in the "audio" field, in which they find pleasurable relaxation. Here amateurism is seen at its best. Interest in the subject was never at a higher pitch than at the present time; according to correspondents in the U.S.A., the same applies in that country, where "hi-fi" tends almost to displace television.

Though there are no spectacular developments to record in sound reproduction progress is steady, but room for improvement still remains. The amplifier has perhaps approached nearest to perfection, and is now produced commercially in forms giving a degree of fidelity that would have been thought unattainable (or even unnecessary) a few years ago. This is a subject in which *Wireless World* has long concerned itself, and for many years we have regularly published designs of high-quality units. The "Williamson" amplifier, since the design was first printed, has achieved world-wide popularity. There is hardly a country in which a version adapted to local needs is not in use.

If the amplifier may at present be regarded as the strongest link in the chain of faithful reproduction, the loudspeaker is the weakest. Obviously the problems to be solved are most difficult, but there has been progress during the past twenty years or so—progress that would be regarded as phenomenal in a less rapidly developing art than our own. The loudspeaker is to some extent a war casualty; it has no special application to warfare, and so comparatively little work was done on it between 1939 and 1945. Since then, much effort has been devoted to its improvement, but the field is one in which there is still much scope for new ideas.

As many of our contributors have pointed out, the general public (as opposed to the growing band of enthusiasts) is not highly critical of reproduction quality. We find it hard to believe, however, that large sections of the public are really satisfied, and it should be easy enough to show them the pleasures they are missing. Unfortunately, however, under present conditions of broadcast distribution, it is only the favoured few who receive a signal capable of being well reproduced. This, as we have said, can only be put right by e.h.f. broadcasting, but, when that comes, the links between studios and transmitters must also be overhauled.

High fidelity, as it is called, is only part of the story. There is also high intelligibility, of greater importance for "public address" purposes and the like. A good deal of data on this subject is already available, but much remains to be done. For public address in places with a high prevailing noise level a more refined approach than mere brute force is needed. It would be fantastic to suggest a "synthetic sound" technique, akin to that demonstrated by Rudolf Pfenniger in 1933, but it is certain that highly artificial characteristics in speech reproduction can effect an improvement. And, apart from public address, we think investigation of synthetic sound production might well continue. In fact, that technique is actually employed with some effect in the Telekinema at the South Bank Exhibition. Though it may be amusing rather than epoch-making, as we said in 1933, the technique may yet provide a useful tool in the world of entertainment.

Loudspeaker Diaphragm Control

The Importance of Radiation Resistance Damping at High Frequencies

By J. MOIR*, M.I.E.E.

IN the May 1950 issue of *Wireless World* the writer reported the results of an experimental examination of the effect of the output impedance of an amplifier upon the transient oscillations of the loudspeaker cone and voice coil. A great deal of further work has been done and it is probable that some of the results may be of interest to the domestic high-quality enthusiast as well as to others with a more professional interest. First of all a brief recapitulation of the earlier results to avoid searching through your file of back numbers. It was shown that :—

1. Critical damping of the speaker voice coil is generally achieved by an amplifier having an output impedance greater than 10–20 per cent of the d.c. resistance of the speaker voice coil. For our purpose critical damping is obtained when the voice coil makes a unidirectional return (no overshoot) from an excursion to one side of its mean position.

2. Amplifier output impedance lower than 20 per cent of the speaker resistance, i.e. damping factors greater than five, produce little further increase in damping because the amplifier output impedance is in series with the d.c. resistance of the voice coil.

3. Other factors remaining constant, further reduction in the amplitude of the transient oscillation can be secured by an increase in flux density in the gap.

It is a characteristic weakness of an experimental approach, that it may do no more than show that the results obtained apply to the particular unit tested, so several units of radically different design were checked, the results being shown in Table 1.

In general a speaker having a low value of gap density will require a lower amplifier output impedance for critical damping than a unit having a high gap density. The majority of speakers with any pretension to high-fidelity performance are high flux density models used in conjunction with negative-feedback amplifiers of low output impedance; consequently it is in just that application where low output impedance is least necessary that it is more often obtained.

In view of the results shown in Table 1 it is thought that the critical damping resistance (amplifier output impedance) for the majority of speakers at present available is greater than about 10–20 per cent of the d.c. resistance of the voice coil.

It is pertinent to enquire about the further improvement that might be secured by applying greater-than-critical damping, as this could no doubt be secured if it proved to be of considerable value in the search for the ultimate in high fidelity. If perfect damping were obtained the motion of the voice coil would at all times be exactly in phase with the current in the voice coil, apparently an ideal state of affairs.

However, before deciding to concentrate on the problem of increasing the voice-coil damping let us take a glance at the performance of one of the other links in the high-quality chain, the listening room in which the high-fidelity enthusiast enjoys the results of his efforts. Reference to an earlier article ("The Acoustics of Small Rooms" *W.W.* May 1944) will show that any enclosure behaves as a resonant structure having an infinity of resonant frequencies given by the Rayleigh equation,

$$f = \frac{c}{2}\left(\frac{A^2}{L^2} + \frac{B^2}{W^2} + \frac{D^2}{H^2}\right)^{-\frac{1}{2}}$$

where c = velocity of sound in air, L = length, W = width, H = height, and A, B, D are the integers 1, 2, 3, 4, etc., substituted in turn. In a typical instance (the writer's lounge) this equation predicts the presence of eight resonant frequencies below about 100 c/s, as shown in Table 2, the presence of most of these having been confirmed by experiment. These are all in the same region of the audio spectrum as the fundamental voice-coil resonance of the majority of good loudspeakers, and there does not appear to be any good reason for believing that their effect upon the quality of reproduction will not be exactly the same as the effect of a speaker resonance when the Q factor ($\omega L/R$) of the room is the same as the Q of the speaker voice-coil system. In both cases an exponentially decaying oscillation at the resonant frequency is added to the tail of every transient signal. An accurate calculation of the acoustic Q of the room is not possible, but a direct measurement of the 51-c/s

* British Thomson Houston Company.

TABLE I

Type of Speaker	D.C. Resistance of Voice Coil	Critical Damping Resistance
High-quality 17in unit ..	9.0 ohms	2.5 ohms
High-quality 12in unit ..	9.0 „	2.0 „
Cheap 7in (Make A) ..	8.2 „	1.2 „
Cheap 7in (Make B) ..	1.5 „	0.6 „
Cheap 7in (Make C) ..	11.5 „	4.7 „

TABLE II

A	B	D	Resonant frequency (c/s)
1	0	0	36.8
0	1	0	51.1
0	0	1	68.6
1	1	0	62.9
0	1	1	85.5
1	0	1	77.6
2	0	0	73.6
0	2	0	102.3

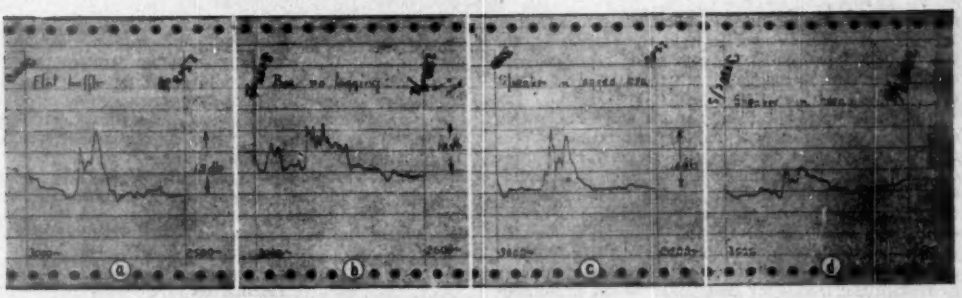


Fig. 1. Residual transient response of a 12-in. loudspeaker over the frequency range 2,500-3,000 c/s, (a) on a flat baffle, (b) in an unlagged box baffle, (c) in box baffle with hair felt lagging, (d) loaded by a short horn.

resonant mode, indicates that it has a Q between 13 and 15, whereas the Q of the damped speaker voice coil is between 0.5 and 1. Table II indicates that there are eight resonant modes below 100 c/s, and as all are known to have Q factors greater than 8, further efforts to obtain greater-than-critical damping of the speaker voice coil would appear to be a mis-directed effort, though the purist may derive some pleasure from "straining at the gnat."

Residual Transients

All the proceeding discussion has been concerned with the low-frequency resonance of the mass of the coil and cone with the compliance of the cone support, but though this is perhaps the most prominent mode, there is a very large number of resonant combinations spread throughout the whole audio frequency range. D. E. L. Shorter (*B.B.C. Quarterly*, Oct. 1946 and *W.W.* Dec. 1946) has developed a technique for checking their presence, his preferred method of expressing the result being to plot the steady-state frequency characteristic together with the frequency characteristic of the residual sound at intervals of 10, 20, 30, 40 milliseconds after the electrical input to the speaker is removed. His results indicate the presence of many high-Q modes of vibration, but in general these "resonant sub-assemblies" are not tightly coupled to the voice coil, the results being that damping applied to the voice coil movement has little effect upon the amplitude of their transient oscillations following an exciting pulse. The looseness of the coupling between voice coil and the resonant elements is shown by the absence of any indication of change in voice-coil impedance at the frequency of resonance. As these mechanical resonances are distributed throughout the whole audio range their aural effect is likely to be of greater importance than the single resonance of the cone and surround. On the other hand, the number of room resonances per octave predicted by the Rayleigh equation increases, and their amplitude decreases, as the frequency rises, and consequently they tend to be relatively less important than the higher-frequency speaker resonances, which Shorter's work has shown to be of high Q with long transient hangovers.

A solution to the problem of damping these high-frequency resonant modes in the speaker may therefore be expected to produce a greater improvement in quality of reproduction than a solution to the problem of obtaining greater-than-critical damping of the basic voice-coil resonance.

On account of the relatively loose mechanical coupling between voice coil and the resonant regions of the cone, electrical damping of the h.f. resonances is extremely difficult (probably impossible), and it is therefore necessary to consider some alternative method. A solution having all the advantages would be to increase the resistive component of the air load upon the cone by modification to the speaker mounting. At the present time there are three main classes of speaker mounting, the flat baffle, vented cabinet including the labyrinth, and the exponential horn, each with its own particular advantages. The flat baffle makes little difference to the resistive component of the air loading on the cone over any large portion of the spectrum, whereas the vented cabinet may be designed or may just happen to increase the resistive loading over the bottom end of the range in the vicinity of the cone resonance, without making any significant contribution elsewhere. The same comment is true of the labyrinth, but the third method, the use of an exponential horn has real advantage in loading the speaker diaphragm, an advantage that is particularly marked in the region between 100 and 1,000 c/s.

Horn Loading

The acoustic resistance at the throat end of an exponential horn rises much more rapidly with increase in frequency than for a cone in an infinite baffle and at low frequency may be 50–100 times the value obtained without the horn. The increase can be calculated without serious difficulty, but the calculation involves a knowledge of the change in effective diaphragm area with frequency, information that can only be obtained experimentally with greater difficulty than there is in directly checking the reduction in transient oscillation due to the addition of the horn.

An experimental check on the correctness of the reasoning always inspires confidence and fortunately some earlier results on a typical 12in cone unit can be quoted. This was tested in a 3ft. sq. baffle, a felt-lined box, and a short exponential horn, the Shorter method of transient measurement being used. Transient oscillations in open cone speakers appear to be greatly affected by time, temperature and many other factors, so it was necessary to find a relatively narrow region of the complete response curve where a transient oscillation occurred in a stable manner, i.e., the results on a flat baffle could be repeated with consistency over periods of several hours. The amplitude of the transient oscillations 20 milliseconds

after the electrical input had been cut off, was then checked with the speaker unit in the flat baffle, the box and the horn, particular care being taken to make certain that the test results for any method of mounting could be repeated.

Fig. 1 illustrates the results and it will be seen that there is little difference in the amplitude of the transient oscillation whether the speaker is mounted on a flat baffle, in an unlagged cabinet or in the same cabinet with thick hair felt lagging. Mounting the unit in a short horn reduces the amplitude of the oscillations by about 12–15 db. Though it may be a coincidence it is worth noting that in this particular case the addition of lagging to the cabinet appears to reduce the frequency band over which prominent oscillation occurs, though increasing the amplitude of the oscillation within that band. This sort of result is generally due to one of the box dimensions being a whole number of quarter wavelengths, and in this case the addition of one inch felt made the back to front dimension a whole number of quarter waves near the frequency of the transients. This point was not followed up, so this should be considered as a tentative explanation only.

Horn loudspeakers are characterized by a solidity and firmness of reproduction which within the writer's experience is not possessed by any other form of

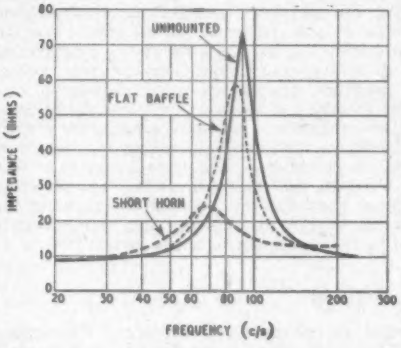


Fig. 2. Effect of loudspeaker mounting on impedance of voice coil.

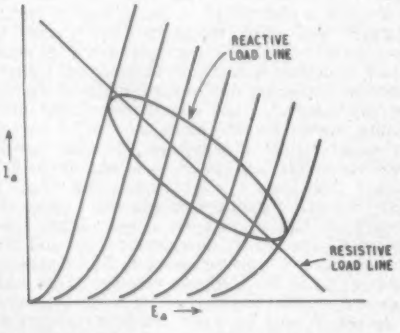


Fig. 3. Indicating the curve path followed by the operating point with a reactive load.

mounting, a characteristic that is believed to be due to effective damping of the cone motion. In this particular case the damping obtained appears to be about twice that expected on the basis of the usual estimations of effective cone diameter.

Earlier, we expressed the view that critical damping of the voice coil is not of particular importance when the loudspeaker is used in a small room but as all the equipment was set up, a particular 12-inch speaker was checked in three mountings to determine the amplifier output impedance required to give critical damping of the basic resonance. The results are as follows :—

TABLE III

Speaker Mounting	Source Impedance for Critical Damping
1. Open on bench	8 ohms
2. In 2,500 cubic inch box ..	2 „
3. In short horn	12 „

This indicates that the Q of an enclosure may be greater than that of the speaker voice coil (i.e., a lower source resistance is required for critical damping) confirming that it may be necessary to use some artifice similar to D. E. L. Shorter's felt partition (*W.W.*, Dec. 1950) if critical damping of an enclosure is really required.

There is one advantage of using a loudspeaker mounting that provides resistive loading of the cone, to which we have not so far referred. A lightly damped mechanically resonant voice coil system will have an impedance/frequency curve with a pronounced peak at the frequency of mechanical resonance, a typical sort of curve being shown in Fig. 2. Over this part of the frequency range the output stage of the amplifier is presented with a load that changes rapidly both in modulus (absolute value) and in phase angle, the change being particularly violent over the few cycles near resonance. A thermionic amplifier cannot provide power for this type of load without introducing serious distortion, a result that will be understood by referring to Fig. 3 showing the anode-voltage/anode-current curves for an output valve with load lines for a purely resistive and for a reactive load added to the diagram. For a resistive load the working path is the straight line shown but for a reactive load the " line " broadens to an ellipse which may take the operating point into regions where the anode current at peak negative grid signals is dangerously near or into cut off, thus increasing the working distortion far above the values taken from the curves for a matched resistive load.

Fig. 4 indicates the results obtained using an amplifier with low-impedance triodes in push pull in the output stage, curve A being the third-harmonic distortion when the amplifier was driving a pure resistance load, and curve B the third harmonic produced when a two-unit speaker combination was substituted. Although this particular speaker assembly has an impedance characteristic which is relatively flat in comparison with the majority of high-fidelity speakers at present on the market, it will be seen to increase the distortion by a factor of two to three times below 200 c/s.

There is therefore considerable merit in adopting a speaker mounting that will reduce the inherent

impedance variations of the speaker unit itself, but it is almost impossible to make any specific statement about the relative advantages of the many types of speaker mountings in this respect. In general the flat baffle has little effect upon the impedance curve of the speaker unit and is therefore worst of all in respect of impedance variation. The vented cabinet may be designed to reduce the natural impedance variation of the basic unit, though there does not seem to be any unanimity of opinion among designers as to what should be done. In the case of the horn-loaded unit considerable reduction in the impedance variation of the basic unit can be secured by appropriate design. Fig. 2 indicates the impedance variation of a particular 12-in speaker unit, in free air, mounted on a 4ft square baffle and finally in an exponential horn designed to be contained in a 10,000 cubic inch box.

As shown in the earlier article these variations in impedance are directly related to the amplitude of the transient oscillations of the speaker, a flat curve such as that for the horn indicating highly damped motion of the coil and cone. In this particular instance the horn shows up to considerable advantage in reducing the amplifier distortion due to load impedance variation and in a large room should show a marked improvement due to the damping of the coil motion.

For completeness we may summarize the conclusions as follows :—

1. Further evidence is produced to indicate that current designs of loudspeaker units are critically damped by an amplifier having an output impedance about 10–20 per cent of the d.c. resistance of the voice coil.

2. Truly aperiodic motion, i.e., greater-than-critical damping is not believed to have any advantage when the speaker is used in a small room, because the transient oscillations of the room are of the same nature and are of much greater amplitude.

3. Effort should rather be directed towards increasing the damping of the cone oscillation at the higher frequencies.

4. Further effort should be directed towards the production of speakers and mountings which give a flat overall voice-coil impedance curve.

5. One solution of both these problems is the use of an exponential horn.

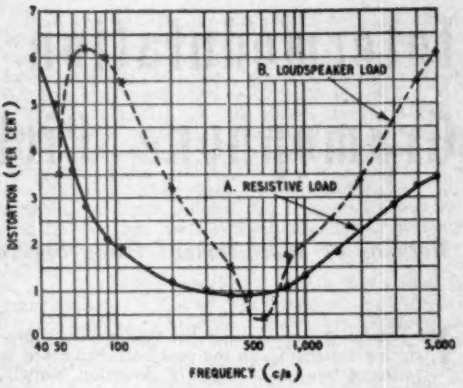


Fig. 4. Third-harmonic distortion produced by resistive and reactive loads.

POST OFFICE REPORT

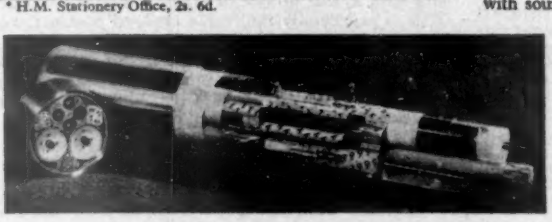
Relaying Television : Radio Interference

REFERENCE is made in the review of the activities of the G.P.O. "Post Office 1950"* to the new coaxial cable which has recently been brought into use as an alternative means of relaying television between Alexandra Palace and Sutton Coldfield. To supplement the brief details of the cable given in the report, we give some data supplied by the manufacturers, Standard Telephones & Cables, Ltd.

The main cable, forming part of the Post Office trunk telephone network, covers a distance of just over 121 miles. The cable terminates at the Museum Telephone Exchange, London, and Telephone House, Birmingham, and the end connections to the transmitters are provided by "tail" cables between the exchanges and the transmitters.

The London-Birmingham cable incorporates two 0.975-inch and four 0.375-inch coaxial tubes. The larger tubes are used, with repeaters at 12-mile intervals, for two-way transmission of 405-line television signals requiring a video bandwidth of approximately 3 Mc/s. The Hankey Television Committee (1943), however, recommended, among other things, that developments be planned on the assumption that a higher definition system, perhaps incorporating colour, would for some time be operated side by side with the present system. The larger tubes may therefore be required for frequencies up to 26 Mc/s, and, in view of this, repeaters have been included at intervals of three miles, although at present only 11 of the 43 are employed. The 0.375-inch tubes are used for broadband telephony purposes, each pair being capable of carrying 600 speech circuits. One section of the "tail" cable (Birmingham to Stoke) uses 0.375-inch tubes for the 405-line transmissions, the repeater stations being spaced six miles apart.

* H.M. Stationery Office, 2s. 6d.



Radio Interference : Whilst complaints of interference with sound broadcasting dealt with by the Post Office increased during 1949 by 68 per cent, those relating to television increased by 350 per cent. The comparative figures were: 1948, sound 40,000; vision 2,000. 1949, 67,000 and 9,000 respectively.

It is interesting to note the principal causes of interference as recorded in "Post Office 1950." Commercial and industrial electrical machinery accounted for 20 per cent of the complaints, inefficient aerial and earth systems, 18 per cent; faulty receivers, 13 per cent; domestic appliances, 12 per cent; and house wiring faults, 8 per cent.

Intermodulation Distortion in Gramophone Pickups

By S. KELLY*

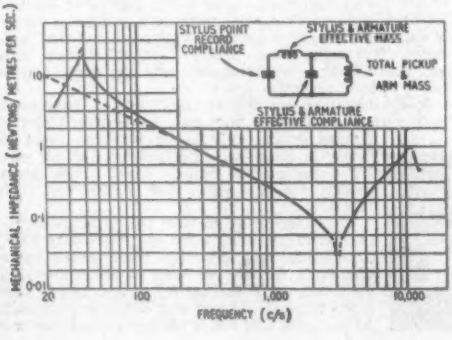
Methods of Measurement Using Special Test Records

IN general, the criterion of the fidelity of a reproducing system has in the past been expressed in terms of two major forms of distortion, namely, variations of amplitude with frequency for constant input, and non-linearity of the transfer characteristic relating output to input over a wide range of amplitudes. Later, recognition was given to phase distortion and transient distortion.

Amongst the earlier methods of specifying performance were those relating the gain of the amplifier to the frequency of the input wave, and usually any components of the output wave differing in frequency from that of the input were neglected. This gives only a rough and ready check of the performance of the amplifier, because the distortion due to a variation in frequency response, as perceived aurally, is usually not very serious. A more distressing form of distortion is that due to non-linearity of the response to input waves of varying amplitude. In this case, the amplitude of the output wave is not directly proportional to that of the input, and it can be shown, where non-linearity exists, that for a pure sinusoidal input the output will contain, in addition to the fundamental frequency, other frequencies harmonically related to it. For the past two decades, the system of assessing non-linearity has been to measure the ratio of the total (r.m.s.) harmonics produced in the device to the fundamental frequency.

Where the harmonics are concordant with the fundamental, the aural effect is less distressing than when inharmonic frequencies are present. As a matter of interest, taking the series as far as the tenth harmonic, only the seventh and ninth harmonics are not musically related to the fundamental. Harmonic distortion, as far as it goes, gives a good measure of the fidelity of the unit but, unfortunately, in most forms of aural communication, two or more frequencies are transmitted simultaneously, and it is generally agreed that simple harmonic distortion is not nearly so distressing as forms of distortion where waves other than those harmonically related to the fundamental are generated. If two different frequencies are applied to a non-linear network, the output wave, in addition to containing the two original and their harmonically related frequencies, produces also combination tones of these two groups, and the majority of these combination tones will not bear any simple harmonic relation to any of the fundamental tones.

Fig. 1. Variation with frequency of the mechanical impedance at the needle top of a popular commercial pickup (1Newton = 10^5 dynes).



Intermodulation is the production of new components having frequencies corresponding to undesired sums and differences of the fundamental and harmonic frequencies of the applied waves. By generally accepted definition, the intermodulation distortion is the arithmetic sum of the amplitudes of the modulation products divided by the amplitude of the high-frequency carrier. The intermodulation system of testing was first described by Harris[1] and was further developed by Frayne and Scoville[2]; a recent analysis is given by Fine[3].

In a gramophone pickup, distortion can take place due to non-linear flux variation in the pickup coil, caused by the armature moving through a non-linear magnetic field; hysteresis in the iron magnetic circuit; and various other design faults; or, more generally, due to the stylus not tracking the groove correctly. (In this article, the "tracking" capabilities of a pickup refer to the ability of the stylus to maintain contact with both walls of the groove under normal operating conditions.)

Under ideal conditions, the stylus would maintain constant contact with both walls of the groove, and the force acting on the stylus would be symmetrical about the vertical centre line. If, however, the vertical force on the stylus is insufficient, the stylus will tend to ride up one or other of the groove walls. This is particularly noticeable on loud passages, and if the acceleration is sufficient, it is possible to throw the stylus completely out of the groove and for it to come to rest one or more grooves away. This distressing phenomenon is only too apparent to most users of the gramophone.

* Cosmocord, Ltd.

[1] J. H. O. Harris *Wireless Engineer*. Vol. 14, pp. 63-72. Feb., 1937.
[2] J. G. Frayne and R. R. Scoville. *J. Soc. Mot. Pic. Eng.* Vol. 32, pp. 648-674. June, 1939.
[3] R. S. Fine. *Audio Engineering*. Vol. 34, pp. 11-14. July, 1950.

Fig. 1 shows the mechanical needle tip impedance of a popular commercial pickup. It will be seen that it consists of two high-impedance points corresponding to high-frequency and low-frequency parallel resonances and a series-resonant frequency (minimum impedance) at 3 kc/s. The high-frequency resonance is determined by the effective mass of the armature and stylus system and the total compliance of the stylus system (the needle tip to record compliance, and the compliance of the stylus itself), and the low-frequency resonance by the mass of the pickup head and the total armature and stylus compliance. When the needle pressure is insufficient, the stylus will "jump the groove" on heavy low-frequency passages, and rattle, or in extreme cases, also "jump the groove" because of the large accelerations often experienced at the high-frequency end.

This particular phenomenon has been evident since the earliest days of recorded sound and is one of the major problems in pickup design to-day; and the advent of long-playing records has done nothing to ease the design problem. The tracking capabilities of a pickup are determined to a large extent by the mechanical impedance at the stylus tip and, as stated before, if the lateral thrust exerts a force greater than that due to the downward pressure, the stylus will tend to ride up the walls of the groove and the symmetrical deflection of the stylus will be lost. This form of distortion is probably the most serious encountered in present-day gramophone reproduction. Unfortunately, the measurement of the mechanical impedance at the stylus point is an extremely difficult matter, but in view of the very high accelerations to which the stylus is subjected, a simple statement of its mechanical impedance is not always sufficient, and some system is required which will show the slightest form of distortion arising from failure to maintain contact between stylus and groove wall. The measurement of intermodulation is about three to five times more sensitive than the measurement of simple harmonic distortion, and this system can easily be adapted to check the tracking capabilities of the gramophone pickup.

The starting point for intermodulation measurements on gramophone pickups is, of course, a record which is engraved with the necessary frequencies and which, in itself, possesses negligible intermodulation components. The intermodulation test record No. JH 138 produced by E.M.I. Studios, Ltd., has been developed for the specific purpose of checking pickups. It runs at 78 r.p.m. and is cut with a standard groove shape, for use with 0.0025in radius styli. One side is cut at 60 c/s and 2,000 c/s, and the reverse side at 400 c/s and 4,000 c/s.

It is intended that the test records be used with a correct bass compensating circuit, so that the equalized output from the pickup is flat when played from a standard recording. The difference level of the two frequencies will then be 12 db on the JH 138.

The specification of the record is as follows:

1st side: The outer band consists of 400-c/s tone at a level of plus 22.5 db, referred to a lateral velocity of 1 cm/sec (r.m.s.), with approximately 4,000 c/s at a level of plus 10.5 db superimposed additively. The difference in levels is 12 db, and an exact integral frequency ratio has been avoided in order to facilitate visual observation of the envelope on a cathode ray tube screen.

The peak lateral velocity of the combined wave is equal to that of a sine wave at a level of plus 24.5 db.

The succeeding ten bands each have the level of both tones (and hence of the combination), reduced by 2 db below that of the foregoing band.

2nd side: The outer band consists of 60-c/s tone at a level of plus 8.6 db, with 2,000-c/s tone at a level of plus 10.3 db superimposed additively. When the 2,000 c/s is reduced in the pickup bass-correction equalizer by the correct amount relative to 60 c/s (i.e., 13.7 db) its effective level will be minus 3.4 db (and not 1.4 db as stated on the record information sheet), i.e., 12 db below the level of the 60-c/s tone.

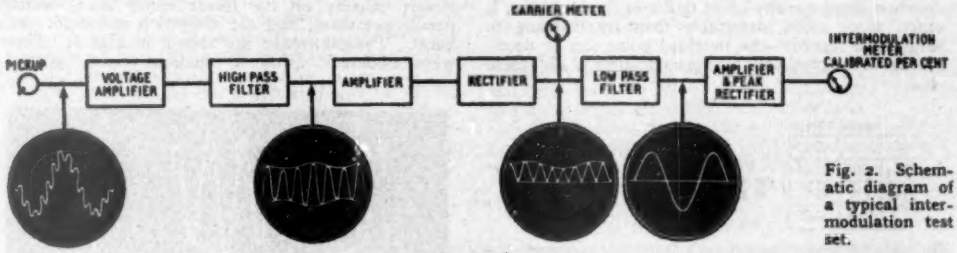


Fig. 2. Schematic diagram of a typical intermodulation test set.

On a velocity basis, the peak lateral velocity of the combined wave is equal to that of a sine wave at a level of plus 15.5 db.

The peak combined amplitude is equivalent to that of a 60-c/s sine wave having a level of plus 10 db.

The succeeding ten bands each have the level of both tones (and hence of the combination) reduced by 2 db below that of the foregoing band. NOTE: The level in decibels above a zero of 1 cm/sec r.m.s. lateral velocity has been measured by the Buchmann and Meyer optical method.

Tolerable Distortion Levels

Frequencies of 400 c/s and 4,000 c/s were chosen because these lie between the two usual resonant frequencies of the pickup system, and are located in the area where high peak energies of speech and music are usually met with. Much practical work has been done, using these frequencies, in the film industry, and it has been shown that if the 400-c/s component has an amplitude 12 db greater than the 4,000-c/s component, extremely good correlation exists between aural and measured distortion. Direct listening tests show that when using 400-4,000 c/s, 10 per cent is a good practical limit for tolerable distortion. Below 10 per cent the distortion is not readily detectable

unless directly compared with the original source. The majority of commercial pickups have the low-frequency resonance between 40 c/s and 80 c/s and it is usually the mechanical impedance of the needle tip at this low resonant frequency that finally determines the tracking capabilities of the pickup. The reverse side of the record is therefore cut with a 60-c/s low frequency component and a 2,000-c/s high frequency component in order to meet these particular tracking test requirements.

The output from the pickup is connected to the intermodulation test set shown in Fig. 2. This consists of a preamplifier of variable gain and minimum distortion (less than 0.5 per cent), a high-pass filter which eliminates the 60-c/s or 400-c/s wave, a buffer amplifier and a rectifier. The output of the rectifier is taken through a low-pass filter to a further buffer amplifier and a peak-reading voltmeter. The carrier level is monitored on the output of the rectifier. It may be possible to give constructional details of this equipment in a subsequent article.

Whilst an intermodulation test set is a very desirable piece of laboratory furniture, it is not absolutely necessary, and much information may be gained by direct listening to the output from the pickup when played on the intermodulation record. The distortion produced when the pickup is not tracking correctly, or when there are any other faults in the amplifier, is much more easily detectable than by listening to single-tone records—the overload point can be determined to a precision of approximately 2 db, these being the amplitude differences between each band.

Fig. 3 shows a very simple set-up using standard laboratory components and a cathode ray oscilloscope. The percentage distortion is given by:

$$\frac{A-B}{A+B} \cdot 100$$

and gives reproduceable results within a few per cent. The c.r.o. trace is shown in Fig. 4.

The inductances indicated in Fig. 3 were constructed with Mullard "Ferroxcube" cores in order to reduce distortion to a minimum. Using Type Y25/11.3 core and former assemblies, 1,750 turns of 42-s.w.g. enamelled wire gave 1.5 henrys and 3,400 turns of 45-s.w.g. were required for 5 henrys. Final adjustment of inductance to give resonance at the required frequency with the actual circuit capacitance was made by rubbing down the centre core or the outer ring to vary the effective air gap. An alternative method would be to use fixed inductances (e.g., Salford Electrical "Gecalloy" toroidal coils on Type GIA cores) and to make any necessary adjustments in the capacitance. If the core is constructed from Stalloy or equivalent material, it must be of adequate cross section and well gapped to reduce iron distortion to the minimum.

In operation, the record is played (starting at the lowest velocity on the inside band) using various needle pressures, and the distortion noted for each band. Typical results are shown in Fig. 5. These were obtained using a medium-priced, general-

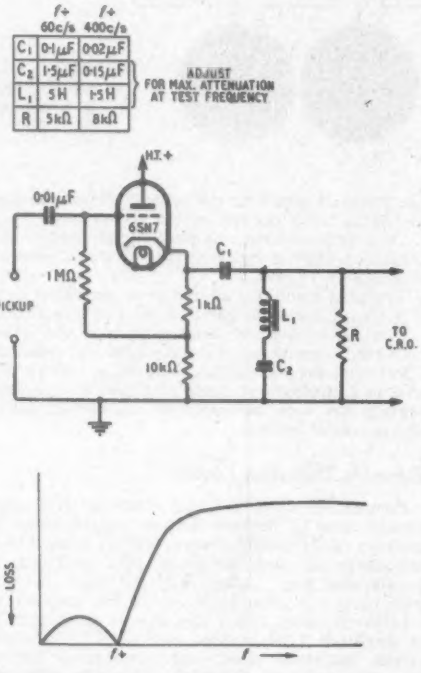


Fig. 3. Simple cathode-follower coupling circuit for measuring intermodulation with a cathode ray oscilloscope. The shape of the response curve is shown inset.

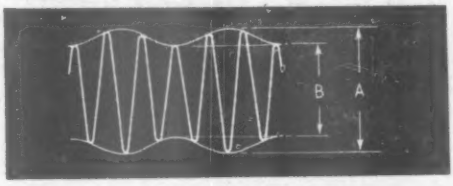
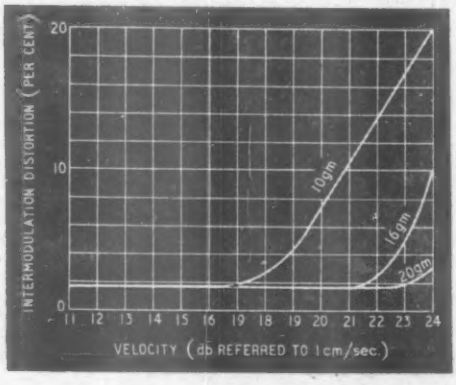


Fig. 4. Form of trace obtained with circuit of Fig. 3.

Fig. 5. Typical results with different needle pressures for a medium-priced general-purpose pickup using test frequencies of 400 and 4,000 c/s.



purpose pickup. On the 400-4,000 c/s side, it is seen that the distortion is low at low velocities, but at a critical velocity the distortion increases very rapidly. Increasing the needle pressure increases the velocity at which the break-up occurs and, for a given needle pressure, this point may be defined as the maximum velocity the pickup will track. Fig. 6 shows results on the same pickup when used on the 60-2,000 c/s side: (A) with the moment of inertia of the pickup adjusted for a resonant frequency of 60 c/s, and (B) for 25 c/s. This was achieved by weighting the head and counterbalancing the arm until the correct needle pressure was obtained. The necessity for reducing the low-frequency resonance as much as possible is certainly brought home in the test. It may be worth while mentioning here that where spring counterbalancing is used, extreme care must be exercised in measuring the needle pressure; during weighing, the height of the stylus from the baseboard must be exactly the same as the top of the record, otherwise large errors will be experienced.

In order to assess the tracking capabilities of the pickup, one determines the highest velocity with which the pickup will track for an intermodulation distortion of less than, say, 10 per cent. Of course, if two pickups are compared, one of which shows a minimum intermodulation distortion of, say, 7 per cent, and the discontinuity at plus 24 db, and the second pickup shows distortion of only 1 per cent, and discontinuity at 20 db, it will generally be considered that the second pickup is the better.

The maximum velocities recorded on the JH 138 approximate to those of commercial 78 r.p.m. recordings (except with pre-emphasis), and it is suggested that the needle pressure required to track successfully *all* bands of the record should be the one specified for general use; of course, good engineering practice requires that some safety margin be allowed, but that is a question for the individual designer.

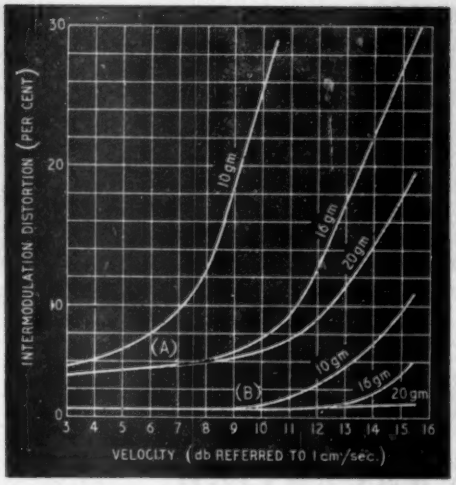


Fig. 6. Results with frequencies of 60 and 2,000 c/s for same pickup as Fig. 5. Low-frequency resonance adjusted (A) to 60 c/s and (B) to 25 c/s.

Acknowledgement is made to W. S. Barrell, B.Sc., and E. W. Berth-Jones, B.Sc., of E.M.I. Studios, Ltd., who produced the record used for these tests.

Technical discussion during the morning session.

A.P.A.E. Exhibition

THE second annual exhibition of the Association of Public Address Engineers was held on May 31 at the Horse Shoe Hotel, Tottenham Court Road, London, W.C.2. Fourteen firms prominent in the field of sound reproduction and distribution took stands and gave demonstrations. Many of the new products shown are described on another page in this issue.

The highlight of the day was the establishment of radio contact with the liner *Caronia*, then about 900 miles out in the Atlantic, and the distribution of two-way conversations over loudspeakers in the exhibition. The demonstration was arranged by A. W. Middleton, of the Post Office Radio Branch, and members were able to discuss the P.O. requirements for the use of land lines Alternative equipments provided by G.E.C. and by National Sound Reproducers were used.

The Chief Radio Officer of the *Caronia* introduced P. Adorian (President, Brit.I.R.E.) and other distinguished passengers aboard, who exchanged greetings with H. J. Leak (President, A.P.A.E.), C. Clarabut (Chairman), A. J. Walker (Hon. Sec.) and members of the Association. A very steady signal of excellent quality was maintained throughout the session, which lasted for about half an hour.

The exhibition was well attended and visitors included representatives of Government Departments, the B.B.C., British Railways and the technical and national Press. The Association are to be congratulated on the success of this exhibition and the work they are doing in the interest of higher standards in sound distribution.

Sir Ian Fraser, C.B.E., M.P., speaking at the official opening of the exhibition of sound reproducing equipment.

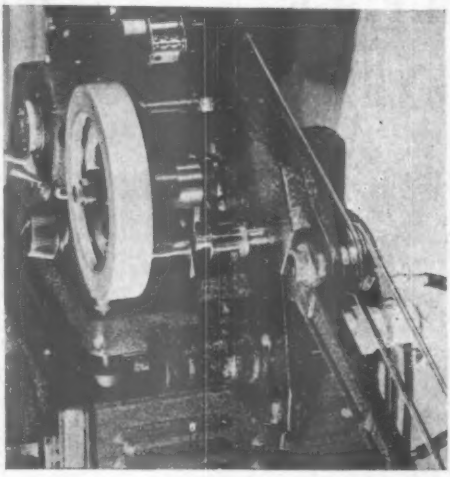
B.S.R.A. Annual Convention

HELD on May 18th-20th, the 1951 convention of the British Sound Recording Association again provided an enjoyable and informative week-end for provincial as well as London members of the Association. As in previous years, the exhibition, which this year was at the Waldorf Hotel, London, W.C.2, was open all day on Sunday as well as Saturday, and was well attended on both days. Details of some of the technical highlights of the exhibition are given elsewhere in this issue. The demonstrations of manufacturers' equipment which were such a successful feature of last year's convention were again given in a series of 20-minute sessions in the Ballroom to full audiences.

The convention opened with a musical evening at the Decca Studios, West Hampstead, when some fine examples of recent microgroove recording were heard under ideal conditions. During the evening a recording was made by Campoli of a violin solo and the audience were able to compare the "live" performance with an immediate playback.

The exhibition was opened by Sir Ian Fraser, who spoke of "talking books" and the debt which blind people owed to sound recording, particularly those who went blind in later years and could not acquire the requisite skill to read fluently by touch. The National Institute for the Blind and St. Dunstan's first issued books in 1936 and Sir Ian paid tribute to the ready technical and material help which the industry had afforded in launching this venture. To-day this library had over 3,000 reader-listeners, and 623 titles were available, with the addition, on the average, of one book per week. The system of recording was on 12in discs, running at either 24 or 33⅓ r.p.m., which thus anticipated the general issue of long-playing records. An experimental tape recorder for talking books which would enable a whole book to be issued in one unit had reached the stage when field trials could be initiated. Using 1,000ft of special ¼in tape with 24 tracks spaced only 0.02in

C. G. H. Chalker receives the President's Cup from Cecil E. Watts assisted by the Hon. Sec., R. W. Lowden. A detail of the prizewinning exhibit, a photomultiplier sound head for a 16mm film projector, is shown below.



centre-to-centre, the tracking mechanism is enclosed in a plastic cassette which is reversed on the driving mechanism and the tape rewound after shifting the pickup head to the next track. The total recording time is of the order of 15 hours. Sir Ian emphasized that it would be some time before the new system could be put into service as very thorough trials must be completed before the capital expenditure involved, something like £100,000, could be authorized.

The annual dinner was made the occasion for the presentation of the President's Cup for the best exhibit in the amateur constructors' competition. The equipment shown in this section was of a very high standard and covered a wide range of amplifiers and components, some of very simple and ingenious design, as well as complete disc, tape and film recorders. The premier award went to Mr. C. G. H. Chalker, of Weymouth, for a sound-reproducing attachment, incorporating an electron multiplier photocell, for a 16mm film projector. The conversion was notable not only for the compactness of design, but for the high standard of workmanship and finish. The Committee Prize for the runner-up was awarded to the Rev. Cyril Butler for a sound-on-film recorder (variable density) which included a very well-made electromagnetic ribbon light valve.

Royal Society Conversazione

AMONG the scientific exhibits at the Royal Society Conversazione on 24th May were several of radio, electronic and acoustic interest.

B. H. Briggs and G. J. Phillips of the Cavendish Laboratory demonstrated a supersonic model showing reflection of radio waves from small irregularities and clouds in the ionosphere. Using triangulated receiving stations and comparing their continuous records on a time basis it has been deduced that the velocity of the pattern of irregularity over the ground is equivalent to winds approaching 200 m.p.h. in the upper atmosphere.

Recent striking developments in the quality of quartz crystals grown by hydrothermal synthesis were shown by C. S. Brown, R. C. Kell and L. A. Thomas (G.E.C.) and Drs. W. A. and Nora Wooster of the Brooklyn Crystallographic Laboratory, Cambridge, who also showed the technique of recovering electrically twinned crystals by applying a combination of mechanical and thermal strains.

Factors governing the efficiency of speech transmission systems were demonstrated by P. Denes and Dr. D. B. Fry of the Phonetics Department, University College, London. Records on magnetic tape were used to show that when peak limitation must be employed, a rising gain/frequency characteristic before "clipping" followed by a falling correction characteristic gives better intelligibility than the converse, though both circuits give a nominally flat overall response.

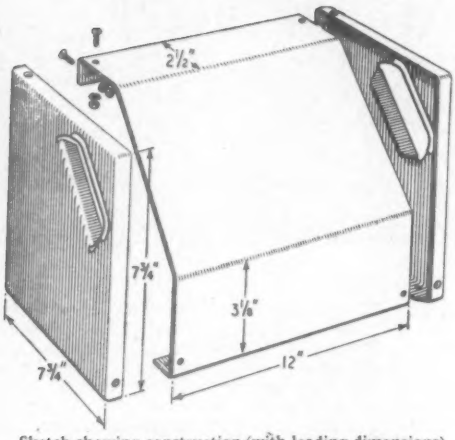
Even more striking was a speech recording, distorted to a point well below intelligibility, which through the influence of psychological factors became easily intelligible when played back after the listener had been given a précis of the information contained in the conversation.

Standardized Chassis

Versatile B.B.C. Design for Housing Permanent or Temporary Equipment

DURING a recent visit to the B.B.C. Engineering Training Department's establishment at Wood Norton, *Wireless World* was attracted by the neat and effective design of a chassis that has apparently been standardized for demonstration apparatus. The chassis is also used for measuring gear and experimental apparatus of a semi-permanent nature, and would appear to have many other applications. Although components and wiring are visible and readily accessible, they are adequately protected in all positions; there are no projections to be broken, and the chassis stands firmly when upside down, on its face, on its back or even on the ends. The layout

Front outside views of a chassis housing a unit to demonstrate the time constant of a CR circuit; note rubber feet.



Sketch showing construction (with leading dimensions) of the B.B.C. standardized chassis. The sloping panel is supported at the sides by two flanges bent in from the cut-away slots that form the hand grips.

has obvious advantages for instructional purposes, and a number of chassis may be stacked on top of each other. The "expendable" part, in which holes will normally be drilled, can be replaced without wasting the end plates.

As the illustrations here show, the general form taken by the chassis is that of a skeleton cabinet having a sloping front, solid end-plates and an open back and base. For a permanent job the back and base could be covered in. Each end-plate has a slot cut out at a "natural angle" for lifting and carrying, so there is accordingly a left- and right-hand end-plate. The top sloping edge of the hand grip is made more comfortable to handle by pressing a strip of metal, formed into a narrow channel, over the upper edge. The chassis illustrated is made of heavy-gauge (about No. 20) tin plate, cellulose sprayed, but any metal or finish can obviously be used.

Dimensions are obviously elastic, but those of the specimen illustrated are given on the accompanying sketch. For some applications it may be convenient to standardize the size of the end-plates, but to use front panels of varying widths.

An angle-piece fixed along the lower back edge imparts rigidity, and may form a convenient mounting for components, as well as providing an anchorage for connecting wires.

HELICAL AERIAL

New High-gain Radiator for 500-Mc/s Television

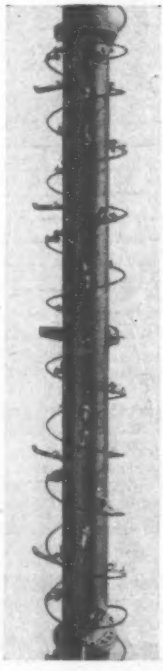
AN aerial of unusual design and possessing the advantage of simplicity of construction and feed has been developed by General Electric of America. It is intended primarily as the radiator for a high-power television station operating on about 500 Mc/s and in the form shown in the illustration radiates an omni-directional wave horizontally polarized and having a very narrow vertical angle. The form of radiation can be described as a thin disc with its axis vertical.

By suitably proportioning the helix the disc of radiation can be given an upward or downward tilt, a very useful feature when the aerial is mounted very high and a local service is required. This feature, and the absence of any appreciable high-angle radiation, should go a long way towards eliminating fading in fringe areas due to reflections and scattering from the upper atmosphere.

This aerial functions on the travelling wave principle and the currents at like points in each turn of the helix must be in phase. This condition will be satisfied when each turn is an integral number of wavelengths in helical circumference, as measured at the velocity of propagation along the helix. All the conditions governing the size of the helix cannot be gone into here, so it must suffice to say that in the aerial shown each turn is two wavelengths in circumference at about 500 Mc/s. The diameter of the metal supporting pole is also important as the amount of energy it absorbs from the aerial governs its performance. It must absorb some, but not too much.

Although the main radiation is in the horizontal plane, some vertical radiation would normally be present in a plain helix. By using two helices connected end-to-end, one having a right- and the other a left-hand pitch, all, or most, of the vertical radiation is cancelled and the horizontal radiation is reinforced. The feed point of this combination is the centre, or junction, of the two helices which form a single unit in the system. As a unit it has a power gain of five compared with a plain dipole, but it is an all-round radiator whereas the dipole gives a figure-of-eight pattern only. Additional units, or bays, can be connected end-to-end to increase the overall gain, a four-bay array giving a power gain of 20. The illustration shows a single bay of the aerial, the right- and left-hand helices being easily identified with the feed point in the centre.

A coaxial cable can be used to feed the helix and when several bays are involved the mast itself can form the main transmission line. The mast would act as the outer conductor and the inner could be tubular also and used to pass up light and power cables for mast-head lighting at night and de-icing in winter. Individual bays drew power from the main feeder by means of "probes" inserted into the mast, the coupling to the centre conductor being adjusted to equalize the power supplied to each bay.



These Valves make News!

NEW TYPES FOR **wide angle Teletubes**

type 6CD6G is a heavy duty line output valve having a peak emission in excess of existing types. It is designed for operation with a maximum screen potential of 175 volts permitting its use in economical television receivers.

Heater Voltage	6.3 volts
Heater Current	2.5 amps
H.T. Supply Voltage	200 volts
Boost Voltage from 6U4GT	150 volts approx.
D.C. Screen Voltage	140 volts
D.C. Anode Current	90 mA
D.C. Screen Current	15 mA
Cathode Bias Resistor	300 ohms
Peak positive pulse anode voltage	5,500 volts
Base-International Octal Sealed	
Height	5¼in. max.
Diameter	2 1/16in. max.

type 6U4GT
efficiency diode service

efficiency diode features an extremely high heater to cathode potential rating, enabling it to be used with fully auto-wound output transformers of high efficiency whilst the heater is being operated from a common supply.

Heater Voltage	6.3 volts
Heater Current	1.2 amps
Peak Anode Current	660 mA max.
Peak Inverse Voltage	3,850 volts max.
Peak heater/cathode voltage (Heater negative to cathode)	3,850 volts max
Peak heater/cathode voltage (Heater positive to cathode)	500 volts max.
D.C. Output Current	138 mA max.
Heater/Cathode Capacity	8.5 pF
Base-International Octal Sealed	
Height	2¾in. max.
Diameter	1 5/16in. max.

When operated from a 200 volt H.T. rail, these valves will provide an E.H.T. voltage of 12-15 kV and fully scan a wide angle (70°) cathode ray tube.

BRIMAR

WRITE NOW TO DEPT. 4530
for data sheets on the above valves.

TECHNICAL ADVICE SERVICE

Standard Telephones and Cables Limited FOOTSCRAY, SIDCUP, KENT

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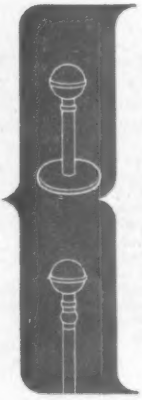
FOR PUBLIC ADDRESS : RECORDING : AMATEUR RADIO



TYPE MIC 22

This model incorporates the famous **Acos** ' Filtercel " insert giving extreme sensitivity and high fidelity. Response is substantially flat from 40-6,000 cps. The microphone is vibration and shock proof and is not affected by low frequency wind noises. Two alternative mountings are available for the MIC 22 head:

MIC 22-2 is supplied as a complete unit incorporating an attractive desk stand with cable side entry.

MIC 22-1 is for fitting to any British or American type standard floor stand and can also be used as a hand microphone.

PRICE £6 · 6. (*Either Model*)

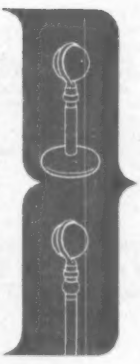
TYPE MIC 16

Incorporates the **Acos** Floating Crystal Sound Cell giving a response substantially flat from 30-10,000 cps. Performance is unaffected by vibration or shock and low frequency wind noises. As in the case of the MIC 22, two alternative mountings for the MIC 16 head are available:

MIC 16-2 is a complete desk stand unit with side cable entry.

MIC 16-1 is ready for fixing to either British or American type floor stands by means of a knurled ring.

PRICE £12 · 12. (*Either Model*)



COSMOCORD LIMITED ENFIELD, MIDDX.

P.S. *As you probably know, we make good pick-ups too, in large numbers. But even larger numbers of people want them. Although, therefore, we expect to be producing still more and still better pick-ups soon, just now we don't advertise pick-ups at all.*

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents.

The Industry and "E.H.F."

IF the industry is keeping quiet, I hope I shall not be considered to be giving away secrets if I suggest some of the factors which (from inside experience a few years ago) I believe to be on its mind.

Everyone agrees that a.m. cannot give better service than f.m., but the economic comparison is not so easy. A reasonably good f.m. receiver costs a little more (even 20 per cent more?) than a typical a.m. receiver. But an a.m. receiver specially designed with noise-suppression, etc., so as to give performance near that of the "standard" f.m. receiver would also be more expensive. So for high-fidelity, noise-free reception there is a strong case for f.m. and not much against it. On the other hand, high fidelity has never been a commercial proposition, and a fierce top cut (euphemistically called "tone-control") is the cheapest form of interference suppressor. If f.m. receivers are likely to be so cheapened by cutting i.f. gain and limiting that they do not behave like f.m. receivers in terms of noise, why bother to put on f.m. in the first place?

But, do not forget, expensive television sets have sold pretty well. Is this because television is so much more drastic a novelty, or is there enough money about nowadays to sell semi-luxury f.m. sets as well? But from the 1951 viewpoint (civilian production likely to be swept aside by military requirements), is there any point in studying the immediate market? Shall we not soon be back to the "austerity" receiver, trying to maintain some broadcast reception as a public service?

Leaving this gloomiest view, let us look at television. In your Editorial you give a visible shudder at the thought of mixed f.m. and a.m., and question the jurisdiction of the Television Advisory Committee. But since, under pressure from the industry, the television service was hastily restored in its exact pre-war form, and a promise given to maintain transmissions acceptable to current-production receivers for a number of years, how could we go all-f.m.? I and others suggested at the time that television sound should be put on f.m., or at least that provision should be made for dual sound channels for f.m. *and* a.m., say one above and one below the vision channel; but nothing was done, and I doubt whether second sound channels could now be fitted into the television frequency allocation. If the Television Advisory Committee insists on retaining a.m. for television sound (which in present circumstances would be reasonable) we could only choose between all-a.m. and mixed systems.

I think, however, that the only hope is for the B.B.C. to aim high, to refuse to be trammelled by the inconveniences which may arise from past errors of policy, and if they believe f.m. is better, let us go ahead with it. If high fidelity is not commercial, let the mass-production merchants make their cheap sets for this band as they do for the m.w. band, but let us have the transmissions available for the benefit of those prepared to pay for high fidelity, and to maintain British prestige in the art of radio transmission.

D. A. BELL.

Birmingham, 11.

YOUR last two editorials have invited comment on the B.B.C. proposal to adopt f.m. for sound broadcasting. I have no doubt when those most interested have seen and have had time to study the B.B.C. reasons for their recommendations, there will be no shortage of that commodity.

It is possible, however, to comment now upon the B.B.C.'s erection of two horizontally polarized aerials for this purpose. One has been erected at Wrotham, one at Sutton Coldfield, and others are under way. Now the television service uses vertical polarization, and one would therefore expect some very sound reasons for departing from the established practice.

I am indeed curious to know how the B.B.C. arrived at their decision. Did they consider that they might be closing the door on v.h.f. car radio? Did they carry out cost studies to make sure that horizontal aerials were not going to be dearer than vertical aerials? Did they realize that if this were the case by say ten shillings per aerial, that the total extra cost to the public could run into millions of pounds? Did they realize that in committing the v.h.f. listener to horizontal polarization they would make reception of different programmes from more than one direction more difficult? This last point would have special importance if independent local v.h.f. stations were set up using sites other than the B.B.C.

It could be that a limited consideration of the cost and convenience of the transmitting aerial, or other factors, led the B.B.C. to their decision in this matter, and it would be reassuring to know that this was not the case.

In Mr. Gillam's article on the design of the Wrotham aerial I am astonished to read that it was designed to accept either three f.m. transmissions or one f.m. and one a.m. transmission, but apparently not three a.m. transmissions. It would seem from this that the B.B.C. knew what conclusions were going to be drawn from the Wrotham experiments before the aerial mast was erected.

J. R. BRINKLEY.

Pye, Limited,
Cambridge.

B.B.C./G.P.O. Standards

IN any monopoly it is a truism to say that only the very highest standards must prevail so that when an organization claims that it is giving "the highest grade of technical service economically possible"[1] it is as well to examine that statement.

There are several amplifiers commercially available having a distortion content guaranteed less than 0.1 per cent with a bandwidth of at least 30–16,000 c/s; many feeder units are available which would not increase the distortion factor by more than 0.02 per cent and "quality" loudspeakers are legion. How many there are in use of these combined receivers it is difficult to estimate, but judging by the continuous advertising there must be a goodly company. Compare this specification then with the latest B.B.C. effort, the "high quality" Wrotham f.m./a.m. station. F.M., 60–15,000 c/s, distortion *not more than* 1 per cent; a.m., 60–10,000 c/s, distortion *not more than* 3 per cent.[2] The B.B.C. is, at best, ten times more distorted, with no greater bandwidth, in its latest transmitter, than the latest commercial receiving equipment. Add to this the distortion represented by the statement "although two high-quality (!) circuits are available from London, even these introduce considerably more distortion than occurs at the transmitter"[3], and a truly deplorable *projected* technical service is presented.

Just what technical or economic barrier prevents the G.P.O. from providing landlines to all provincial transmitters and studios with a bandwidth of 30—9,000 c/s with a distortion factor of not more than 0.1 per cent? Just what prevents the modification of B.B.C. transmitters to the same standard? Better by far to put the cost of the projected f.m. stations, £200,000 each, into new landlines and modulators than to spend an astro-

[1] F. A. Peachy, M.I.E.E. G. Stannard, B.Sc., and C. Gunn-Russell, M.A., Design Department, B.B.C. *Electronic Engineering*, May, 1951.
[2] and [3] J. P. Hawker, *R.S.G.B. Bulletin*, March, 1951.

nomical sum covering the country with f.m. only to find that the landlines put us as you were!

Or is it that the B.B.C. has a different standard for the provinces than that for London? Judging by the frequency at which we hear "the discontinuity in the characteristic caused by the operation of the B.B.C. modulator in Class B" (D. T. N. Williamson in *Wireless World* on his amplifier) it may be so, for in several visits to the London area this "discontinuity" was not heard.

In all this I am concerned with "static" distortion as opposed to "controlled" distortion. To explain what I mean may I conclude with a story. Some two years ago I looked forward to a broadcast of a piano recital which I knew was to originate in Manchester. It began at 10.30 p.m.; by 10.40 the harmonic distortion (mostly seventh!) was such that I was constrained to telephone to Manchester. The engineer I spoke to was a long time coming back to the telephone after I had explained matters; during the period he was away the volume of sound from my receiver decreased approximately 6db and for the remaining fifteen minutes the pianist gave me much pleasure. My receiver is non-A.V.C. and no turning down of my volume control could have reduced the distortion.

C. R. WHITE.

Bradford, Yorkshire.

Festival Demonstrations

THERE is so much that is worth publicizing in our British achievements in the fields of radio, television and radar that I am sure most *Wireless World* readers will be as disappointed as I was at the miserable show we have been given at our one and only Telekinema. By its name I had thought we were to see television at its very best on both closed circuits and live transmissions, and that stereoscopic film and so-called stereophonic sound were to be thrown in as additional attractions.

Instead, we have a quarter of an hour of short-line transmission from the foyer of the theatre with, until now, only two O.B.s from the B.B.C.—fifteen short minutes entirely swamped by about forty minutes of stereoscopic film. To confine television to constricted interviews in the foyer and give so much of the film programme to synthetic art is literally throwing away the substance for the shadow.

It would surely be more to our advantage nationally to demonstrate what British engineers can do in the way of transmission and reception and I rather think the public expects it. The fact that by means of the marvellous television receiver and amplifier at the theatre we can see the B.B.C. transmissions at almost full cinema size is bound to impress everyone, particularly those overseas critics of our 405-line transmission. The Telekinema can show more clearly than anything else the very high standard of our broadcast transmissions. It would be better to show this in preference to the "phoney" part of the stereo films.

W. MACLANACHAN.

London, W.8.

"Bass Without Big Baffles"

THE ideal, expressed by your correspondent L. E. A. Bourn in the June issue, of trying to render to the ear a sound as near to the natural as possible is certainly a good one, providing that it is reasonably attainable in practice. Whilst the musical analogies, which he was able to quote with considerable authority, may be taken for or against the possible usefulness of a simulated bass, I should like to say that my amplifier was designed more from the point of view of the evidence afforded by physiological facts. The harmonic constitution of the various instrumental tones is capable of considerable alteration by passage through the mechanism of the ear.

Space would not permit a discourse into the causes of non-linearity in the ear and it will suffice to say that, at low frequencies where amplitudes are of necessity large, distortion by aural harmonics (in terms of sensation levels) is considerable when judged by the usual electrical standards. Admittedly, organ builders may employ mainly the 2nd and 3rd harmonics of a fundamental, but, in the case of the ear, subjective harmonics up to the 8th or 9th order can be detected by special methods. The characteristic curve of the ear resembles that of the grid voltage/anode current curve of a triode valve, and the ear is accustomed to being driven beyond the linear part of its curve at low frequencies with sound levels above the threshold of audibility. I am sure that your correspondent would find the results of electrical distortion at *low* frequencies surprisingly deceptive to the ear.

Dissonance between modulation products in the amplifier and other notes in the tempered musical scale would not differ materially from that occurring in the ear receiving *pure* tones, and is inevitable.

Much of the information quoted can be found in "Hearing," 1938, S. S. Stevens and H. Davis, published by Chapman & Hall.

K. A. EXLEY.

Leeds, 6.

THE article by K. A. Exley in your April issue brings a most interesting and thought-provoking fresh approach to the old problem of obtaining the effect of bass without the use of a large cabinet. I would like to make one or two comments on his suggestions.

The method used by organ builders of producing the effect of a single large pedal pipe from a number of smaller pipes sounding certain harmonics is not very satisfactory when the tone to be simulated contains a large proportion of fundamental. Nor are the best results obtained unless the building is of considerable size with a fair amount of reverberation. The second and third harmonics are the most important; the higher harmonics do not add appreciably to the fundamental tone and are only necessary for the synthesis of certain well-defined tone "colours."

No steps are taken in the amplifier circuit put forward by Dr. Exley to reduce higher-order harmonics produced by V3. A simple RC filter between this valve and the point of entry to the amplifier might improve the smoothness of the synthetic bass. As this is only required below about 100 cycles, reduction of output could begin at 250 cycles or so. Also the output from V3 is fed into the amplifier at a point within the feedback chain, so that this input will be subject to degeneration just as would any spurious signal, such as hum, produced within the amplifier.

A further point is that the valve V3 is at a point following the volume control. While the input to this valve is considerable, having been subject to amplification in V1, it is likely that as the volume control setting is moved towards minimum the proportion of harmonic bass to signal will fall, and a point will be reached at which distortion in V3 is very small.

Might it be more satisfactory if the input (from pick-up or tuner) is taken first to a splitter, the anode of which feeds the harmonic generator valve, the output from this and the signal from the cathode of the splitter then being combined and fed to the main volume control? Output from the harmonic generator valve could first be passed through an RC filter to remove higher harmonics, and a volume control potentiometer preceding the junction with the main signal path would allow the proportion of harmonic bass to be varied to suit individual taste. Some amplification of signal prior to feeding to the distorting valve could be obtained by having the anode resistor of the splitter greater than the cathode load resistor. An advantage of this method would be that the entire harmonic bass circuit could be constructed around a single double-triode valve, such as 6SL7, and could be applied to any normal amplifier, thus avoiding the need for much extra constructional work on existing equipment.

F. D. C. BAKER.

Tunbridge Wells, Kent.

DEVELOPMENTS IN

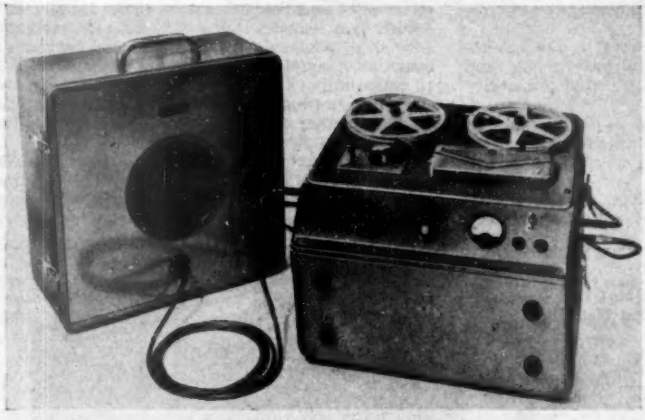
Sound Reproduction

Equipment Shown at the Recent B.S.R.A. and A.P.A.E. Exhibitions

Recording.—The new E.M.I. portable magnetic recorder, Type TR50, which weighs 59 lb and measures $17\frac{1}{2} \times 16 \times 12\frac{1}{2}$ in, is available for tape speeds of either 15 and $7\frac{1}{2}$ in/sec or $7\frac{1}{2}$ and $3\frac{3}{4}$ in/sec. The frequency response is 50 c/s to 12,000 c/s within ±2 db of the response at 1 kc/s at 15 in/sec, 8,000 c/s at $7\frac{1}{2}$ in/sec and 4,000 c/s at $3\frac{3}{4}$ in/sec. It is claimed that speed variations are less than 0.2 per cent at 15 and 7 in/sec and less than 0.3 per cent at $3\frac{3}{4}$ in/sec. Equalizer networks appropriate to the conditions are automatically brought into circuit by the speed selector control.

M.S.S. have now entered the tape recording field with a portable machine (Type PMR/1) using standard 1,200-ft reels of tape and designed to give a response of 50 to 9,000 c/s ± 2 db. The interesting feature of this machine is that, in addition to a 7-watt output for a 15-ohm loudspeaker, there is a second output designed to match the impedance of the M.S.S. disc-recording cutter head, so that direct dubbing from tape to disc can be carried out without additional amplifiers.

A push-pull output stage giving sufficient power for classroom work or use in small halls is provided in the new Model 1A tape recorder made by Simon Sound Service. Tape speeds of $3\frac{3}{4}$ and $7\frac{1}{2}$ in/sec are available and a single control lever working in a gate, rather on the lines of a car gear-change, gives foolproof choice of recording, playback and fast forward or rewind speeds. Attention has been given



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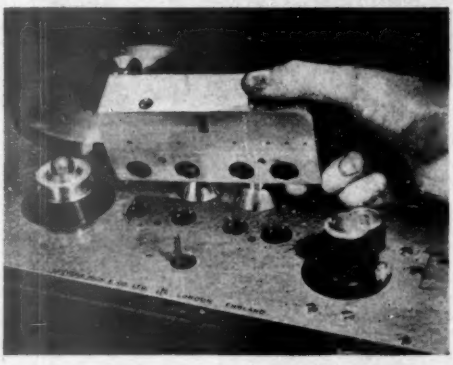

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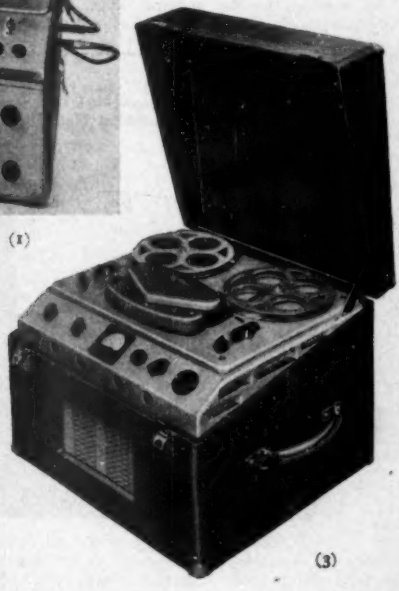


(3)

New tape recorders. (1) M.S.S. Type PMR/1. (2) Detachable head assembly in the Leevers-Rich Type "C." (3) E.M.I. Type TR50.

to speedy acceleration and deceleration of the tape to facilitate transcription work.

The special tape recorder designed by Leevers, Rich & Company for professional use runs entirely from a 12-volt battery and provides "studio" quality in transportable form. It is particularly suitable for sound recording in film production. The specification is designed to meet wide variations in climate and the equipment has already been used "on location" in Norway and Africa. Everything has been done to ensure continuity of service in the field; the head assembly, for instance, is provided with plug-in connections and is instantly replaceable. A pulse synchronizing system developed for use with this recorder uses a separate track on the magnetic tape which records pulses at picture frame speed generated by the camera. A common a.c. power supply is unnecessary and both camera and recorder can thus be operated by separate batteries if necessary.

A magnetic tape recorder designed for synchronizing sound to silent film projectors was shown by Excel Sound Services (49, Bradford Road, Shipley) working in conjunction with a 16-mm projector. A capstan speed of 120 r.p.m. is chosen to work with the top sprocket of a cine projector and a 10-in diameter flywheel weighing 9 lb is incorporated to ensure smooth operation. The sound reproducer controls the projector motor speed through an electro-mechanical compensating relay.

British Ferrograph, were showing a new closed-loop tape deck (Model 67) for advertising and other applications where short-period repetitive reproduction is required.

A wider choice of tape is now available than last year. Durex Abrasives are in full production with their MC1-111 medium-coercivity tape, for which full magnetic data are available.

In addition to the original Type 65 "Emitape," Electrical and Musical Industries are now making a high-coercivity grade (Type H60) for use at the lower tape speeds.

Low-impedance recording, playback and erase heads have been added to the range of components made by Audigraph, who have also introduced a new series (Type 200) of self-aligning twin-track heads with tape guides formed in the moulded body.

Amplifiers.—Developments in quality amplifiers have been mainly in their auxiliary equipment. The Acoustical Manufacturing Company have produced, for use with their Q.U.A.D. amplifier, a new radio tuner unit which makes use of two stages of r.f. amplification feeding a high-level diode detector. To obtain low detector distortion, equal loading is provided for the signal and d.c. component and a low output (10-20 mV) at low impedance (5,000 ohms) is accepted. This is coupled to the main amplifier via a screened cable. A five-position switch gives the choice of four pre-set stations or gramophone and indicator lamps show the programme selected.

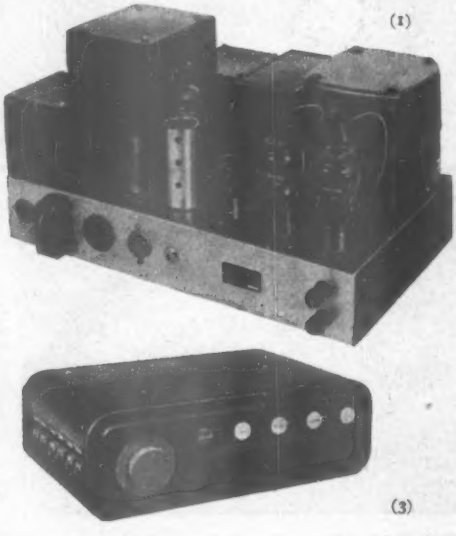
Goodsell were showing a range of "Williamson-type" amplifiers with output ratings from 6 to 15 watts. One version, for export, incorporates the new Partridge CFB output transformer assembled on the latest "C"-type core.

H. J. Leak & Company have developed a new remote control pre-amplifier (Type RC/PA/U) for use with their TL/12 power amplifier. It has switch selection of equalization characteristics for all current British and American disc recording characteristics as well as independent bass, treble and volume controls. A microphone input requires only 3 mV for 10 watts output from the main amplifier. This firm was also showing the new B.B.C. monitoring loudspeaker unit for which the TL/12 amplifier has been specified.

A new 50-watt power amplifier for sound distribution (Model 501) has been added to the Grampian range. It has provision for mixing inputs from four microphones and a gramophone pickup. Separate

(1) Goodsell amplifier with "C"-core output transformer. (2) British Ferrograph Model 67 continuous tape recorder. (3) Acoustical Manufacturing Company's radio tuner unit.

(2)



(1)

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bass and treble tone controls and a bass boost for high-quality pickups are incorporated, and a switched meter provides a check on all valve emissions. The screen supply to the output valves is neon-stabilized.

Loudspeakers.—A new loudspeaker unit for the reproduction of frequencies above 3,000 c/s has been developed by Wharfedale. This is the "Super 5" which is a direct radiator with a 3½-in aperture using a cloth surround for the diaphragm and an aluminium-wound speech coil. A massive Alcomax III magnet with 1-in centre pole provides a flux density of 13,000 gauss.

Vitavox have made available the S2 pressure unit and CN157 horn which forms the middle- and high-frequency unit in the "Klipschorn" loudspeaker. It is designed for a frequency range of 200 c/s to 20,000 c/s and the pressure unit, although intended primarily to form part of studio and theatre installations, is suitable for domestic applications with the wider distribution provided by the cellular construction of the throat of the CN157 horn.

Designed for high-powered sound distribution systems, electronic organs, etc., the new Goodmans "Axiom 18" has a peak power-handling capacity of 50 watts. The 18-in diaphragm assembly is detachable for servicing and incorporates a dustproof linen spider suspension. The coil impedance is 6 ohms, and the magnet provides a flux density of 14,500 gauss.

A new lightweight pickup (P100) has been produced by the M.S.S. Recording Company. It functions with a downward pressure of only 5-10 gm and is available with interchangeable heads for standard or microgroove records. The moving-iron armature works in generous air gaps and the output is given as −34 db referred to 1V r.m.s. from a 1 cm/sec + 10 db direct recording, when used with coupling transformer and equalizer.

Sound Distribution.—An interesting communication system for hospitals has been developed by Ardente for use in conjunction with the normal broadcast sound distribution system. The patients' pillowphones are of the moving-coil type and are provided with a switch at the side which converts them to microphones and also calls the duty nurse, who can enquire the patients' needs without having to traverse the length of the ward. Also shown by Ardente was a schools receiver installation which, in addition to normal B.B.C. programmes, provides automatic class-changing signals from a synchronous clock, and incorporates an oscillator for a fire alarm signal tone and microphone priority in emergency.

The Magneta Time Company were showing a comprehensive sectional amplifier assembly (Model S11) in which up to four units for radio, gramophone, speech, fire and time signals can be stacked on a basic 50-watt power amplifier to make a neat cabinet assembly when capped by a rounded top section.

Remote control of sound distribution equipment over P.O. lines was demonstrated by G.E.C., who were showing examples of their rack-mounted Main Station and Out Station installations, as well as a wide range of smaller sound-amplifying equipment and components.

A new hand microphone (Type DP3) has been produced by Grampian. It is of the moving-coil type with metal diaphragm and its characteristics have been designed to give smooth response over the range of speech frequencies, with the minimum of extraneous pickup. A press-to-talk switch with heavy nickel-silver blades incorporates a third contact for relay operation.

Goodmans "Axiom 18" loudspeaker.

Below: Wharfedale "Super 5" h.f. unit.

Grampian Type DP3 hand microphone.

Right: Vitavox Type B52 microphone, with built-in transformer, on desk stand.

Vitavox have produced an alternative version of their B50 hand microphone with a built-in transformer to give either 500-600, 10,000 or 100,000 ohms output impedance. A desk cradle for these microphones is also available.

To the already comprehensive range of Truvox loudspeakers for sound distribution has been added a new lightweight 10-watt pressure driving unit, without transformer (Type SD47) to meet the demand for simplified installation and servicing adjustment.

An interesting device for sound distribution systems employing long lines was shown by the Antone Company of Epsom. It is known as the "Modulite" and consists of an Aldis-type signal lamp fixed to the loudspeaker standard and relay operated by speech currents. The narrow beam, which is focused on the operating or microphone position, gives clear indication that remote speakers are functioning.

WORLD OF WIRELESS

New Home Service Stations • Instruments and Electronic Shows • Radio Convention • Birthday Honours • Notes and News

B.B.C. Reception

TWELVE new low-power stations are to be brought into use by the B.B.C. to improve reception of the Home Service in certain areas. This was announced by the Postmaster-General in reply to a question in the House of Commons.

He stated that to mitigate as far as possible the deterioration caused mainly by foreign station interference on wavelengths allocated to the United Kingdom under the Copenhagen Plan, low-power medium-wave transmitters are to be erected in the vicinities of the following places:

	kc/s	Service
Barnstaple ..	1052 ..	W. of England
Barrow ..	1484 ..	N. of England
Bexhill ..	1457 ..	W. of England
Brighton ..	1457 ..	W. of England
Cromer ..	908 ..	London
Dumfries ..	809 ..	Scottish
Folkestone ..	1457 ..	W. of England
Montrose ..	1484 ..	Scottish
Pwllheli ..	881 ..	Welsh
Ramsgate ..	1484 ..	London
Scarborough ..	1151 ..	N. Ireland
Whitehaven ..	692 ..	N. of England

The P.M.G. stated that selection of wavelengths to provide a satisfactory service to the maximum number of listeners in these localities without spoiling reception elsewhere presented considerable difficulty, and it restricted the choice of the particular Regional Programmes which could be provided.

The B.B.C. hopes that eight of the new stations will be operating before next winter.

Instruments Exhibition

THE first exhibition to be devoted exclusively to the British instrument industry opens for ten days at Olympia, London, on July 4th.

Of the 140-odd exhibitors, nearly forty will be showing instruments and equipment of radio and electronic interest.

The exhibition, which will be in the National Hall, will be open daily from 11 a.m. to 8 p.m. except on July 14th when it closes at 6 p.m. Admission is 2s 6d. The organizers are F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2.

Solder Film

THE not-inappropriate title of "The Vital Link" has been chosen for a well-produced educational film made for H. J. Enthoven & Sons, manufacturers of "Superspeed" cored solder. Though solder in itself may be a humble commodity, difficult to glamourize, the soundness or otherwise of connections made by its help in radio equipment is truly a vital matter. The film, which deals with both manufacture and use, may be borrowed by societies, study groups, firms and similar bodies.

Brit. I.R.E. Convention

THE third and fourth sessions of the Radio Convention sponsored by the British Institution of Radio Engineers will be held at University College, Southampton, from July 24th-27th.

"Radiocommunication and Broadcasting" is the theme of the third session (24th and 25th) at which Paul Adorian (president of the Institution) will be chairman. The papers to be read include:—

"Switching Methods for V.H.F. Networks" by E. P. Fairbairn (G.E.C.)
"Broadcast Reception on Large Merchant Vessels" by R. Copsey (Redifon).
"Submarine Cable Communications" by E. W. Smith, Ph.D., B.Sc. (Eng.), (Submarine Cables).
"High-Frequency Broadcast Transmission with Vertical Radiation" by P. Adorian and A. H. Dickinson (Rediffusion).
"Recent Developments in Vibrators and Vibrator Power Packs" by J. H. Mitchell, B.Sc., Ph.D. (Ericsson).
"Some Problems Encountered in the Design of Marine Transmitters" by D. J. Spooner (Redifon).
"Plastic Insulated Land Communication Cables" by A. L. Meyers, B.Sc. (Eng.), (T.C.M.).
"Wireless Broadcasting and Rediffusion Systems for Colonial Territories" by A. Cross and F. R. Yardley (Rediffusion).
"Some Future Developments in Air Radio" by G. R. Scott-Farnie and M. I. Forsyth-Grant (International Aeradio).
"The Design of the Domestic A.M. Sound Receiver" by F. T. Lett (E.M.I.).
"The Design of a Comparator A.M./F.M. Receiver for Broadcast Reception" by F. H. Beaumont (Fitton).

The fourth session (26th and 27th) is devoted to "Radio Aids to Navigation"; the first day's papers being largely on marine aids and the second on aeronautical aids. The chairman at this session will be F. S. Barton (T.R.D.E.) and the opening address will be given by Sir Robert Watson Watt. Among the papers to be read are:—

"The Use of Radio in the Navigation and Operation of Civil Aircraft" by D. H. C. Scholes (Plessey).
"The Application of Telecommunications to Civil 'Airways'" by D. P. Taylor (M.C.A.).
"Harbour Radar" by Grp. Capt. E. Fennessy (Decca).
"Random Phase Variations of C.W. Signals in the 70-130-kc/s Band" by W. T. Sanderson (Decca).
"The Seaman's Requirements for Navigational Aids" by R. F. Hansford (Sperry) and Capt. F. J. Wylie, R.N. (Retd.).
"Search Radar for Aircraft" by P. Stride (E. K. Cole).
"Some Navigational and Air Traffic Control Problems of Civil Aviation and the Application of Radio to Their Solution" by G. W. Stalebrass (M.C.A.).

"Trader Year Book"

IN the 1951 edition of "The Wireless and Electrical Trader Year Book" considerable space is devoted to television data and includes condensed specifications (valves and c.r.t. used, i.f., e.h.t. supply and aerial input) of current television receivers. Valve and cathode-ray tube base connections, with over 200 valve base diagrams, and abridged specifications of current radio receivers are also included.

The directory sections, printed on distinctively tinted papers, include manufacturers' and wholesalers' addresses, proprietary names and a classified buyers' guide.

Published by the Trader Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1, the 292-page Year Book costs 10s 6d, post free.

Electronics Exhibition

THE sixth annual exhibition of electronic devices organized by the North-Western Branch of the Institution of Electronics, will be held at the College of Technology, Manchester, on July 24th (from 2.30 to 9 p.m.) and on July 25th and 26th (from 10 a.m. to 9 p.m.).

In addition to the section devoted to manufacturers' products, a non-commercial section, composed of exhibits from the Universities and from scientific associations, will be included. Home-constructed television receivers will be demonstrated and an amateur station will operate throughout the exhibition.

Admission will be by ticket obtainable from W. Birtwistle, 17, Blackwater Street, Rochdale, Lancs.

PERSONALITIES

Sir Ian Fraser, C.B.E., M.P., the new president of the Radio Industries Club, has a strong link with the industry and broadcasting. He was a member of the Government Broadcasting Committee (1925-26) and was a Governor of the B.B.C. from 1937-39 and again from 1941-46.

Sir Ernest Fisk, deputy chairman and managing director of Electric and Musical Industries, Ltd., was unanimously re-elected president of the International Federation of the Phonographic Industry at a recent meeting attended by representatives of fourteen countries.

W. A. C. Maskell, B.Sc.(Eng.), M.I.E.E., has been appointed general manager of the General Electric Company's radio and television works at

Coventry, in succession to the late W. H. Peters. He joined the company in 1925 and during the war was chief engineer of the G.E.C. radio works in the Bradford area. When these works

W. A. C. MASKELL, B.Sc. (Eng.)

closed in 1946 he returned to the head office to become deputy manager of the radio department. He is succeeded as deputy manager by **R. G. E. Mayo**, who joined the G.E.C. in 1927.

O. W. Humphreys, B.Sc., F.Inst.P., M.I.E.E., who has been manager of the G.E.C. Research Laboratories for the past two years, has been appointed director of the Laboratories. He has also been elected a member of the Board of the Institute of Physics.

Philip V. Hunter, C.B.E., deputy chairman of B.I. Callender's Cables & chairman of the Telegraph Condenser Co. and of B.I. Callender's Construction Co., has had conferred upon him an Honorary Membership of the I.E.E. for "his outstanding services to the electrical industry and to the Institution."

HONOURS

Among the recipients of Birthday Honours conferred by the King are:—**W. K. Brasher**, secretary of the Institution of Electrical Engineers since 1939, and **G. R. Parsons**, G.P.O., who was secretary to the Beveridge Broadcasting Committee, who become C.B.E.; **E. G. Chadder**, who was recently appointed senior superintendent engineer (sound), B.B.C., and **H. Noble**, senior principal scientific officer at the Admiralty Signal and Radar Establishment, Haslemere, who are made O.B.E.; **A. Davenport**, general works manager, Salford Electrical Instruments, **F. Mitchell**, Flight Radio Officer, B.O.A.C., **E. H. Niblett**, technical and works director, Wright & Weaire, Ltd., and **W. H. Ritch**, chief Radio Officer, s.s. *Mahronda*, who are made M.B.E.

IN BRIEF

Licences.—Of the 12,452,300 broadcast receiving licences current in the U.K. at the end of April, 825,600 were for television receivers. During the first four months of this year there has been an increase of 239,500 television licences and a decrease of 82,200 "sound" licences, giving an overall increase of 157,300.

India's first high-power medium-wave broadcasting station was recently opened in Calcutta. The 50-kW transmitter operates on 1,000 kc/s.

Radio-controlled model aircraft, ships and tanks will be a feature of *The Model Engineer* Exhibition, to be held at the New Royal Horticultural Hall, Westminster, from August 22nd to September 1st. The Society of Model Aeronautical Engineers has introduced a new competition limited to radio-controlled model aircraft for which entry forms and rules are obtainable from the Manager, *The Model Engineer*, Exhibition Offices, 23, Great Queen Street, London, W.C.2. The closing date for entries is July 16th.

B.B.C. Exhibition.—Burns' plea "O wad some power the giftie gie us, to see oursels as others see us!" is answered at the exhibition staged by the B.B.C. at 201, Piccadilly, London, W.1, where visitors can see themselves televised. Disc and tape recorders are demonstrated, and the cutting of sapphires for tipping both recording and reproducing needles is shown. Admission to the exhibition, which will be open daily, except Sundays, from 11 a.m. to 10 p.m. until September 30th, is 1s.

Plastics and Radio.—The part played by plastics in the radio industry—from the insulation of wire to the production of a console television cabinet—was shown at the recent Plastics Exhibition at Olympia, organized by our associate journal, *British Plastics*. Papers read at the Convention held in conjunction with the exhibition covered the development of plastics and their application to various industries.

Decca.—The North British chain of Decca Navigator stations, opened on June 7th, is planned to serve the north western approaches and has its master station at Kidsdale, Wigtown.

Dielectrics.—The University of Liverpool, in co-operation with the Institute of Physics and the British Electrical and Allied Industries Research Association, is holding a summer school on the Theory of Dielectrics at the University from July 19th to 21st. This will be followed by a conference on dielectrics from July 23rd to 25th. Particulars of both functions may be obtained from Dr. Szigeti, Department of Physics, The University, Liverpool, 7, or from the Deputy Secretary of the Institute of Physics, 47, Belgrave Square, London, S.W.1.

"Voices Under the Sea."—A documentary 30-minute film about the cableship services of Cable & Wireless, Ltd., is now being shown daily in the Telekinema at the South Bank Exhibition. "Voices Under the Sea," as it is called, tells the story of a repair by one of the Company's ships, c.s. *Norseman*, off Ascension Island. Copies of the film, both 16- and 35-mm, will be available for the use of clubs and similar organizations from the Company's Public Relations Office, Electra House, Victoria Embankment, London, W.C.2. Foreign language versions are also being prepared.

"Elettra II," the new Marconi Marine research yacht, which recently returned from a demonstration cruise to Dutch, Belgian and French ports, will be at Frederikshavn for the Danish Fishing Festival (July 10th-13th) and at Ostend for the Fourth International Congress of the Sea (July 20th-22nd).

House of Lords.—The recently completed restoration of the House of Lords afforded an opportunity for installing a new sound reinforcing system. Equipment similar to that installed in the new Chamber of the House of Commons (see *Wireless World*, November, 1950) has been provided by Tannoy.

Radio Industries Club.—It is recorded in the report of the committee of the Radio Industries Club for the year ended March 31st, 1951, that during the year under review the membership increased by 29 to 713. The new officers are: Sir Ian Fraser, president; A. J. Dew, vice-president; J. G. G. Noble, chairman; and Owen Pawsey, vice-chairman. W. E. Miller continues as honorary secretary.

R.O.U. Officers.—The new chairman of the Radio Officers' Union is Radio Officer H. Moore, who has been on the marine staff of the Marconi International Marine Communication Co. since 1920. The new vice-chairman is Signals Officer B. Pettman, who, after fourteen years' service at sea, became an Air Radio Officer in 1938. He is at present at the B.O.A.C., Brentford.

I.E.E.—The annual report of the I.E.E. presented at the 79th annual general meeting of the Institution shows that the membership at April 1st this year was 36,558. This figure is an increase of 1,010 on last year and a 100% increase on the 1938 figure.

Institute of Physics.—The annual report of the Institute records an increase of 201 in the membership during 1950. At the end of the year the total was 3,858.

Air Radio Licences.—Detailed information of all examinations for aircraft radio operators and maintenance staff held under the auspices of the Ministry of Civil Aviation, including syllabi and specimen papers, are given in the M.C.A. publication "Certification and Licensing of Aircraft Radio Personnel—MCAP 90" issued by H.M. Stationery Office, price 1s 6d. Particular attention is drawn by the M.C.A. to the revised syllabus for the R/T (General) examination.

Television Servicing.—E.M.I. Sales & Service, Ltd.—the distributing and servicing organization for "His Master's Voice" and Marconiphone products—has equipped premises at 109, Piccadilly, Manchester, for training television servicing technicians. Particulars of the courses are obtainable from E.M.I. Institutes, Ltd., 10, Pembridge Square, London, W.2, or the Training Division, E.M.I. Sales & Service, Ltd., Sheraton Works, Wadsworth Road, Greenford, Middx.

British Radio.—A 28-page booklet reviewing the activities of the various branches of the British radio industry has been produced by the Radio Industry Council for circulation overseas prior to the 18th National Radio Exhibition which opens at Earls Court, London, on August 28th.

All Mod. Con.—"WANTED.—Bungalow (preferably) or House . . . Within television range. . . ." (Advertisement in Sussex newspaper.)

Courses on the technology of synthetic resin adhesives for both the woodworking industry and the electrical manufacturing and engineering industry are planned by Aero Research, Ltd., for the summer school which they are organizing for September 23rd to 29th at Cambridge University. The mornings

will be devoted to lectures and the afternoons to practical demonstrations at the Company's works at Duxford. The use of the synthetic dual-purpose resin "Aerolite K" in the production of receiver cabinets is described in "Aero Research Technical Notes, No. 99," which is issued by the Company's Technical Service Department.

Consol Charts.—In reply to a question in the House of Commons regarding the over-printing of charts of British coastal waters with Consol lines of bearing, the Parliamentary Secretary to the Admiralty stated that four Admiralty Charts were being prepared. The charts are on a small scale but over-printing on the larger scale charts is not being undertaken as it is not considered that the accuracy of the system permits its use for coastal navigation.

Amateur Radio.—Cardiff members of the R.S.G.B. are to have a stand at the Welsh Industries Fair to be held in the town from July 4th to 18th. A transmitter (GW3WIF) will be in operation each day. The Festival Land Travel Exhibition, which includes an amateur transmitting station, will visit Birmingham (August 4th-25th) when it leaves Leeds on July 14th.

Army Specialists.—Among the 130-odd trades and occupations listed by the War Office in the booklet giving details of the Army's reconstituted Supplementary Reserve are those of Radio Mechanics and Tele-mechanics in Royal Signals and Radio Engineers in R.E.M.E. The object of the Supplementary Reserve, which, it is pointed out, is not part of the Territorial Army, is to provide the technical and administrative units which the Army would need on mobilization. Details of recruitment, training and pay are given in the booklet "The Supplementary Reserve" issued by the War Office.

Patent Office Library, at 25, Southampton Buildings, Chancery Lane, London, W.C.2, has extended its hours of opening. From Mondays to Fridays inclusive, it now closes at 9.0 instead of 6.0. On Saturdays it will continue to close at 5.0. It opens daily at 10.0.

R.F. Heating.—The annual report of the British Electrical and Allied Manufacturers' Association records that a glossary of terms and a code of safety precautions for industrial high-frequency heating equipment has been prepared and will be issued by the Association in a few months' time.

Television Without Eyestrain.—A leaflet giving advice on how to enjoy television viewing without eyestrain has been issued by the Association of Optical Practitioners, 65, Brook Street, London, W.1. The opinion of the Association is that, provided a few simple rules are observed, television is not harmful to the eyes. The enthusiasm of children should, however, be curbed and they should not be allowed to view television for long periods without rest.

Exporting Television.—British television receivers operating on American standards—525 lines, 60 frames, negative picture modulation—are wanted by the Mexican firm of Cia. Mercantil Campbell S.A., Popocatepetl 131, Mexico, to whom quotations should be sent.

INDUSTRIAL NEWS

Spain has ordered from Marconi's complete equipment for two television stations to be installed at Madrid and Barcelona. The order comprises two 5-kW vision transmitters, two 3-kW f.m. sound transmitters, two complete radiating systems each including a combining unit, 3-tier turnstile aerial and transmission line; four complete e.h.f. radio links; studios in both cities, including telecine equipment; two mobile outside broadcasting units; production and commentators' equipments, communication systems, and studio lighting equipment.

U.N. Television.—Three Marconi Image Orthicon cameras and ancillary equipment have been ordered by the United Nations Organization for installation at its new headquarters in New York.

Sweden's broadcasting authority has ordered from Standard Telephones & Cables, Ltd., a new high-power broadcasting transmitter for erection in Stockholm. The company has recently installed new transmitters at Hörby, Sundsvall and Gothenburg.

Marconi radio equipment has been chosen as the standard for aircraft of the Royal New Zealand Air Force. Initially three standard types of R.N.Z.A.F. aircraft, Devons, Hastings and Freighters, are to be fitted. The equipment will include AD107 high-power communication transmitters, AD94 communication receivers, AD401 intercommunication systems and the Marconi automatic direction finder AD7092A. A lower-power transmitter-receiver (AD97/108) will provide a secondary h.f. communication station.

R.C.A. Patents.—Electric and Musical Industries, Ltd., have made arrangements whereby they are able to grant licences for broadcast sound and television receivers under all patents of the Radio Corporation of America, in Great Britain, Northern Ireland and Eire for inventions made on or after January 1st, 1945. Licences under patents of R.C.A. on inventions made prior to that date are included in a previous arrangement.

Pye, Ltd., supplied the mobile radio-telephone equipment by which the Austin A40 car (on a record-breaking trip round the world) can keep in touch with the aircraft which will be accompanying it carrying spares and supplies.

Starr British Products.—The first two words in the name of the manufacturer of Starr gramophone needles were inadvertently transposed in the advertisement which appeared on p. 92 of our last issue.

Marconi's staff magazine, *The Marconi Companies and Their People*, has been awarded the special prize for staff magazines in a competition organized by the British Direct Mail Advertising Association.

"The Elliott Journal." — Elliott Brothers (London), Ltd., have produced a house journal, which, published bi-annually, will give a periodic review of developments in engineering and physical science, with particular reference to the work of the company. In the first issue of 36 pages there are articles on magnetic amplifiers and a phase-front plotter for centimetre-wave aerials.

A. H. Hunt, Ltd., advise us that, in view of the uncertainty of obtaining adequate supplies of suitable carton material, they have withdrawn from their current catalogue Type L24 dry electrolytic capacitors in cardboard cartons. Whilst no new orders can be accepted for this capacitor, every effort will be made to meet existing commitments.

American Tape Recorders.—Arrangements have been made by Byer Industries Pty., Ltd., of 8, Dorcas Street, Melbourne, Australia, for the exclusive manufacture for the sterling area of the Magnecorder tape recorder made by Magnecord, Inc., of Chicago, Ill.

Standard Telephones & Cables, Ltd., announce that arrangements have been concluded whereby the long association between the company and Western Electric, Inc., in the whole field of telecommunications will be continued.

Multicore Solders, Ltd., are to occupy a factory being erected by the Government-sponsored Hemel Hempstead New Town Corporation. It will be the second to be opened in the new town and is stated to be the largest in the world constructed solely for the manufacture of cored solder.

Stella Radio and Television Co., Ltd., the recently formed Company for marketing and distributing radio and television receivers—the first of which will be a table and console model with 12in tubes—announce that Eric W. Brades has been appointed a director and sales manager. He was with Philips Electrical for 21 years. The company's address is Oxford House, 9-15, Oxford Street, London, W.1.

A. C. Cossor, Ltd., announce that L. L. Roberts, general manager of the Company, and director and general manager of Cossor Radar, Ltd., has resigned from these posts.

Sound Sales, Ltd., have appointed J. L. Matthews in succession to C. D. C. Gledhill as London Sales Manager at Lloyds Bank Chambers, 125, Oxford Street, W.1. (Tel.: Gerrard 8782.)

Painton & Co., Ltd., announce the appointment of J. R. Slatter, A.M.I.E.E., as works manager. He was, until recently, works manager of the Igranic Electric Co., Bedford. R. Steven, B.Sc., has been appointed sales manager.

Gregg Radio, Ltd., of Bond Street, Hull, advise us that their London office at 39, Hyde Park Square, W.2, can accept equipment for servicing and supply spare parts for their radio and electro-medical equipment.

Mullard, Ltd., is the new name adopted by Mullard Electronic Products, Ltd.

E. K. Cole, Ltd., have received a further order from the Derbythire Education Committee for forty-six 10-watt school radio equipments.

Duke & Co., of 219, Ilford Lane, Ilford, Essex, have opened a branch at 621, Romford Road, London, E.12. (Tel.: Grangewood 6677.)

Radiocraft, Ltd., of 25, Beardell Street, Upper Norwood, S.E.19, announce that their telephone number is now Gipsy Hill 5585.

Stewart Transformers, Ltd., have moved to 75, Kilburn Lane, London, N.W.10.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Is it as good as a "Belling-Lee"?

Some types of "Belling-Lee" television aerials may be a few shillings dearer, but the fact remains that "Belling-Lee" aerials give the best performance both electrically and mechanically. The result is that more and still more dealers

On the left is a "Belling-Lee" ½ wave "H" type aerial, mounted on a 9-ft. metal mast.

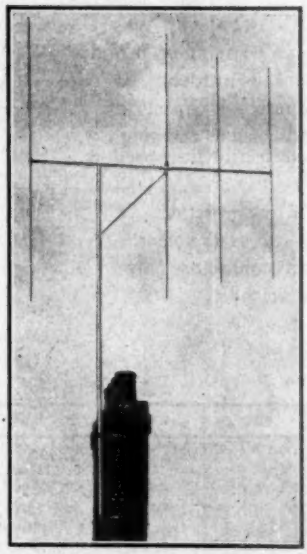
The "Belling-Lee" "Multirod", a multi-element "fringe" area array, is shown on the right.

are recommending "Belling-Lee" aerials, and orders are coming in very much quicker than we can produce the aerials. We have doubled our production floor space, and are still adding to it, but still the orders come in faster. At the time of writing this page (incidentally weeks before you read it) we are giving the best possible delivery obtainable under the present conditions. We have several worthy competitors, but be wary, there is a lot of rubbish about, and the owner of a new television receiver is apt to be impatient and to demand "some kind of aerial" immediately. The wise man in a new television service area, orders his aerial well in advance, and if he is very wise he has it erected. Remember it takes an hour or two to put up an aerial, whereas only a few minutes to plug in a receiver. Aerial riggers in a new area are very busy men and there is a limit to the number of hours any man can work. If a new transmitter opens during the time of short days and poor weather conditions the situation is greatly aggravated. Think about these things and order your aerial. You may not get it for many weeks. Don't find yourself in the position of having to buy an aerial of unknown worth. Buy one with a well-known name, buy the best by "Belling-Lee."

BELLING & LEE LTD

Two Aerials: One Chimney Stack

Our post-bag continues to furnish us with a crop of topics and problems and the following, we feel sure, is a problem which may confront many readers of this page.



The correspondent informed us that he lived some 80 odd miles from the Sutton Coldfield transmitter in the West Yorkshire area; in this location (he was using a "Multirod") reception varied from good to moderate, but on the whole he was satisfied. Recently, his immediate neighbour also installed a "Multirod," which was erected on the same chimney stack. The two aerials were separated by the width of the stack, a distance of some 3-4 feet.

Since the inception of the second aerial, our correspondent was experiencing a deterioration of signal. Could we advise him?

An extract from our reply read as follows:—

"Where two aerials are mounted on the same chimney stack, difficulties are nearly always introduced. Numerous factors are involved, including the distance between the aerials, their relative positions and height, and the wave distribution in the particular area."

The whole object of putting an aerial out of doors is to give increased height, and to get the collector clear of the metal objects, conduits, water pipes, etc. The neighbour's aerial acts as "a foreign body." It shouldn't be there, its presence may cause reflections and it may absorb a considerable part of the available signal. In some cases it may improve a signal, but not often. It is possible that with some receivers, a spurious signal is injected into the aerial which the neighbouring aerial will pick up as interference. It is not always easy to obtain perfect conditions, but when we recommend that an aerial should be kept clear of metal objects, these include neighbouring aerials.

List numbers of the senior range "Viewrod" ½ wave spaced "H" type aerials

L.801/Channel/C: Mast head mounting with mast cap. No pole.

L.801/Channel/L: Chimney mounting with double lashings and mast cap. No pole.

L.801/Channel/9: 9ft. High-tensile alloy mast and cap. Single chimney lashing. Double bracket.

L.801/Channel/12: 12ft. High-tensile alloy mast and cap. Double chimney lashings.

P.S.

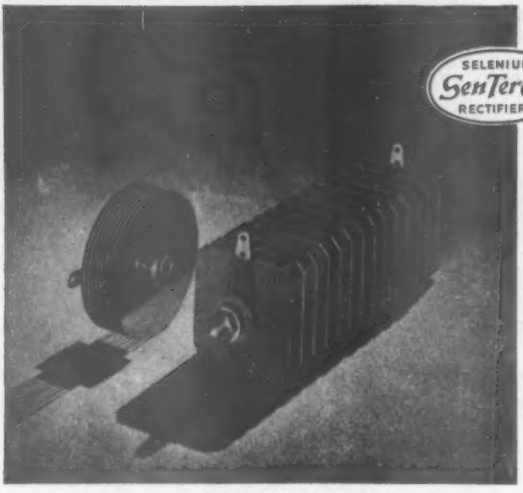
Did you know? A motor car can seriously interfere with electronic research and television reception.

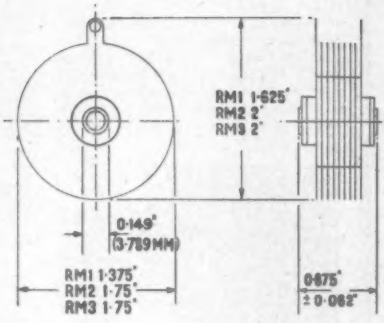
Fit a "Belling-Lee" suppressor L.1274 or L.630 to the distributor lead, does not affect engine performance and helps an industry

Light . . . robust . . . durable

SELENIUM SenTerCel RECTIFIERS

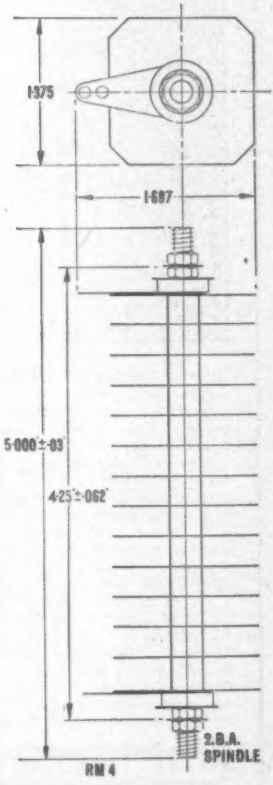
miniature H.T. Rectifiers





SenTerCel miniature H.T. Selenium rectifiers offer these unique features :

- Instant starting — no warming-up period
- Unlimited instantaneous overload
- No limit to size of reservoir capacitor
- Withstand overloads such as charging current of deformed electrolytic capacitors.
- Low heat dissipation
- Practically indestructible in service
- Simple mounting — no valve holder
- Simple wiring — two connectors only
- Small size . . . low weight
- Low cost



Ratings

TYPE	RM1		RM2		RM3		RM4		
Maximum ambient temperature	35°C	55°C	35°C	55°C	35°C	55°C	35°C	40°C	55°C
Maximum output current (mean)	60mA	30mA	100mA	60mA	120mA	90mA	275mA	250mA	125mA
Maximum input voltage (r.m.s.)	125V		125V		125V		250V		
Maximum peak inverse voltage	350V		350V		350V		700V		
Max. instantaneous peak current	Unlimited		Unlimited		Unlimited		Unlimited		
Weight	1 oz.		1.4 oz.		2 oz.		4.5 oz.		

Standard Telephones and Cables Limited

Registered Office : Connaught House, Aldwych, London, W.C.2

RECTIFIER DIVISION : WARWICK ROAD, BOREHAM WOOD, HERTS. *Phone : Elstree 2401* *Grams : SenTerCel Borehamwood*

Frequency Modulation

3.—The Receiver

By "CATHODE RAY"

THE only really essential difference between an f.m. and an a.m. receiver is the special kind of detector needed for converting r.f. frequency variations into a.f. amplitude variations. In fact, as I mentioned in the first instalment, any ordinary a.m. receiver can be adapted for f.m. by the simple dodge of mistuning it slightly so that the slope of the resonance curve is used instead of the peak—provided, of course, that the receiver can be tuned at all to the frequencies used by f.m. stations, which are normally in the v.h.f. band. But this method is unsatisfactory in almost every respect; its sensitivity is poor, its distortion is large, and it fails to take full advantage of the noise-subduing capabilities of f.m. Quite a number of special f.m. detectors have been devised, but the most important—and the only one I am going to describe—is the one employing the phase discriminator.

This is quite easy to understand on a basis of elementary circuit theory; in particular, the parallel resonant circuit (Fig. 1). It can be imagined as being used to tune the anode of the i.f. valve feeding the detector. The resistance of the tuning coil is represented by r, and the Q of the circuit is $2\pi fL/r$. At exactly the resonant frequency, the reactances of C and L are equal and opposite, so that they cancel one another out, and the whole circuit behaves as if it were a high resistance, equal to $2\pi fLQ$. So a given current through it develops a high voltage across it, and since the circuit is effectively a resistance the voltage is in phase with the current. We know, of course, that if the frequency is raised or lowered the voltage will fall off each side, in the usual resonance curve, and the higher the Q the sharper the resonance peak. But in this case we are not so much concerned with the changing magnitude of the voltage as with its phase relative to the current. At frequencies higher than resonance, the reactance of L is higher than that of C, so most of the current will go through the C branch, with the result that it will lead the voltage across the circuit; at frequencies below resonance most of the current will go through the L branch and lag the voltage. The sharper the resonance (due to high Q) the more rapid the phase shift as the frequency is altered. The phase shift reaches $\pm 45°$ when the frequency shift from resonance is approximately $\pm 1/2Q$ times the resonant frequency. For example, if the circuit is tuned to an i.f. of 10Mc/s and has a Q of 50, the 45° points are reached when the frequency has been shifted about $1/100 \times 10 = 0.1$Mc/s or 100kc/s. Fig. 2 shows the complete phase curve for such a tuning circuit. Note that I have plotted the phase of the voltage relative to current because the current is the constant thing in the anode circuit of a pentode.

Suppose now that this circuit is tuned to an f.m. station. When the carrier wave is unmodulated, the voltage developed across the circuit is in phase with the current through it, but if the carrier is modulated with a frequency swing of ± 100kc/s the phase of the voltage will swing between $+45°$ and $-45°$ approximately. What we want is some means of translating these phase swings into voltage swings.

The alternating current through the coil sets up an alternating magnetic flux around it, in phase with itself. If another coil is coupled to it, the flux will generate a voltage in that, too, proportional to the rate of change of flux, and therefore (as explained in any book on a.c.) 90° out of phase with it. Whether this voltage is 90° behind or ahead of the current depends on which way round one takes the terminals of the secondary coil. If the winding is centre-tapped, then relative to the centre point the two terminals will provide voltages both leading and lagging (because the method of connection makes them opposite in

Right: Fig. 1. Parallel tuned circuit, the phase changes in which are the basis of the frequency discriminator which is the heart of an f.m. receiver. Here r represents the loss resistance of the circuit.

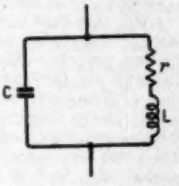
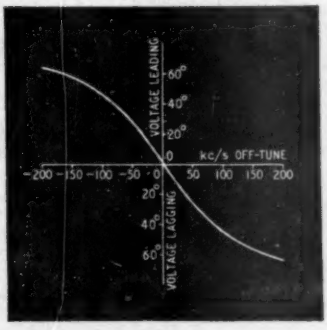


Fig. 2. Graph of phase difference between voltage and current in Fig. 1 when $r/L = 0.4\pi \times 10^6$. The useful range of a discriminator is usually $\pm 45°$.



Below: Fig. 3. Theoretical discriminator circuit, lettered to correspond with the vector diagrams, Fig. 4.

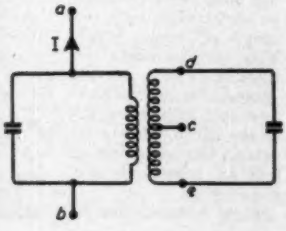
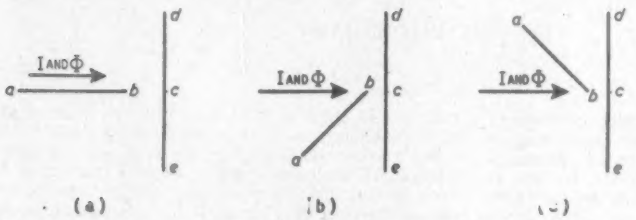


Fig. 4. Vector diagrams relating to Fig. 3 when the voltage V_{ab} is (a) in phase with, (b) leading, and (c) lagging the current I and consequently the alternating magnetic flux Φ, which generates V_{cd} and V_{ce}. If *b* were joined to *c*, to represent the discriminator connection, these diagrams would show how V_{ad} and V_{ae} vary in opposite ways with phase angle.



polarity, or 180° out of phase with one another).

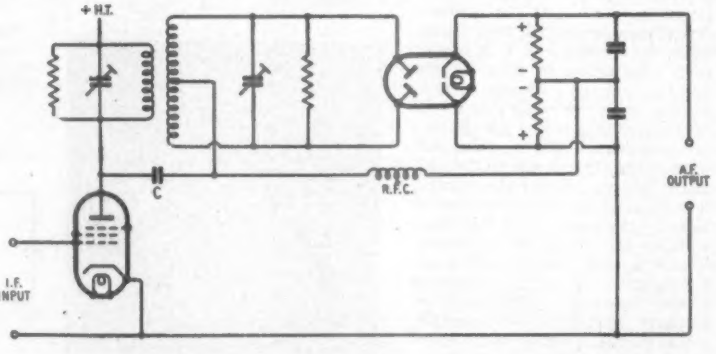
If we don't draw some sort of relative phase diagram pretty soon we shall lose track of the situation. We could, of course, draw a few sample cycles of the voltages and currents in their relative phase relationships, but in that form it is difficult to see the results of adding any two together; so let us draw a vector diagram. After all, I didn't spend three months explaining vector diagrams for no purpose! Fig. 3 is the circuit to date (the loss resistances being, as usual, taken as read), and Fig. 4(a) is the vector diagram when the coils are at resonance. The purpose of the secondary winding should now be coming into view: since the phases of the voltages produced by it are locked to the current in the primary, any phase shift between primary voltage and current (due, say, to f.m.) means a phase shift between primary and secondary voltages. The downward frequency swing makes V_{ab} lead I, as in Fig. 4(b), and the upward swing makes it lag, as at (c). By simply connecting the "live" terminal of the primary, *b*, to the centre tap of the secondary, *c*, one gets two alternating voltages, V_{ad} and V_{ae}, that vary in *magnitude* as the signal *frequency* swings. This could be seen more clearly by redrawing the Fig. 4 vector diagrams, with *b* and *c* coinciding. These i.f. voltages can be rectified by the usual detector diodes, giving two voltages that vary relative to one another at the frequency of modulation. At resonance they are equal and opposite, so cancel one another out. When the frequency swings below resonance, V_{ad} exceeds V_{ae}, and if its rectified output is connected so as to be positive the resultant is positive. When the frequency is higher than resonance V_{ae} exceeds V_{ad} and the resultant is negative. One gets a curve rather like Fig. 2 but with output voltage as the vertical scale instead of phase shift. You will probably see that $V_{ad} - V_{ae}$ is not going to be exactly proportional to phase shift, so the curve will not be exactly the same, but it will be something like it.

Now it would not be worth while setting up an f.m. system, with a nice quiet background, if the reproduction were bound to be horribly distorted. In fact, we expect really high-class results. So this matter of the precise shape of the curve is very important. If the detector output voltage did follow Fig. 2 exactly, there would be a considerable amount of third-harmonic distortion, unless the phase-shift were confined to a few degrees each side of centre, and then the quality of the output would be at the expense of quantity.

But before discussing this in detail perhaps we had better descend from all this rather abstract theory to take a look at a practical discriminator circuit, Fig. 5. It should be easy to identify the Fig. 3 transformer, with its primary in the anode circuit of the last i.f. valve, and the two halves of the secondary feeding diode rectifiers, the outputs of which are connected in opposite polarity to yield the required a.f. voltage. If point *c* in Fig. 3 were connected directly to *b* it would bring the whole secondary and rectifier outfit to practically + h.t. voltage, which would be inconvenient. So a blocking capacitor C is used, of sufficient capacitance to offer negligible i.f. impedance. The d.c. connection for the rectifiers is made, without short-circuiting the i.f., by the choke RFC. The capacitors across the diode load resistors are the beginning of a filter for removing frequencies above the audio limit and also providing de-emphasis of the upper audio frequencies. Note that resistors are used across primary and secondary windings for adjusting the Q of the tuned circuits to give the best results with the standard frequency deviation. If the tuning were too sharp, the slope of the Fig. 2 curve would be very steep at first and would quickly flatten out, causing both positive and negative peaks of large-amplitude a.f. waveforms to be flattened. As it is, some compensation for the curvature shown in Fig. 2 will clearly be necessary.

And here we must realize that the foregoing simple account of how the discriminator works has ignored a number of complications. For one thing, we have

Fig. 5. Essentials of a practical discriminator circuit. The connection between the primary and secondary coils is made via C to block the steady h.t. voltage.



been assuming that the primary current and the voltages remain constant all over the working frequency deviation. Since the primary has a resonance peak as well as a phase shift curve, this assumption is rather rash. Then we have taken no account of the secondary current, which generates a magnetic flux that will inevitably affect the primary. The extent to which it does so depends on the closeness of coupling. These two effects tend to offset one another, because if the coupling is closer than "critical" the secondary current will raise double humps on the primary resonance curve. Another thing that affects the relationship between phase shift and output voltage difference is the transformer ratio. This, at least, can be fairly easily studied, by drawing the vector diagram for various values of $de : ab$ and in each case plotting $ad - ae$ against phase angle. But choosing the best combination of all three parameters—transformer ratio, coupling, and Q—to produce a voltage-difference/phase-angle curve that exactly compensates for the curvature of Fig. 2, so that the voltage-difference/frequency-swing graph is as nearly as possible a straight line, is rather too complicated to go into here. Sufficient to note that it can be done very successfully (Fig. 6 is an example), but that it is quite a tricky business, and if one fails to hit on the right combination the result is likely to be considerable harmonic distortion. Set builders please note!

Even when all is well with the discriminator, its merits will be wasted if the transmission is not accurately tuned in. There are actually two reasons for this, one of which will appear when we consider impulsive noise, but in the meantime there is the very obvious one that if the carrier frequency is appreciably off the centre of the Fig. 6 curve the range of linear operation is reduced and there is a risk of the frequency swing going beyond one of the sharp bends, with dire effects on the louder parts of the programme. This condition sets in before mistuning is sufficient to make a noticeable difference to volume, nor is there the same tone change as with a.m., so listeners who are not very sensitive to distortion (and how many of them there are!) may have difficulty in getting spot-on unless automatic frequency control is used. Fortunately this is not too difficult to arrange, because we already have a large part of an a.f.c. system present—the frequency discriminator. When a station is properly tuned in, there should be no net d.c. output from the diodes—only a.f. a.c. Mistuning causes a d.c. component, and if this is used to control a reactance valve in parallel with the oscillator tuning, the oscillator frequency is shifted until the tuning is close to centre.

Removing Amplitude Variations

The receiver must be a superhet, of course, to change the incoming v.h.f. to a frequency at which the signal can be amplified effectively. An i.f. in the region of 10Mc/s is likely. And even if there is a.f.c. it is wise to pay special attention to the frequency-stability of the oscillator. If the incoming signal is 100Mc/s, a drift of only 0.1% is 100kc/s—more than the full frequency deviation of the transmitter! With ordinary tuning components, the warming-up drift might get even beyond the control of a.f.c. Another thing: great care must be taken to avoid any frequency modulation of the oscillator, especially by the power-supply a.c., since a frequency swing as little as 0.001% would be enough to cause hum.

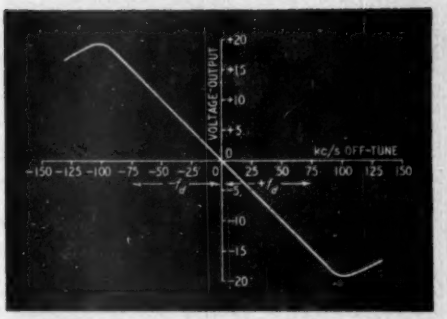


Fig. 6. When the best circuit values and adjustments are in use, the curvature of Fig. 2 is almost completely neutralized in the overall characteristic. As shown here, the characteristic is suitable for f.m. with a deviation f_d of $\pm$75kc/s.

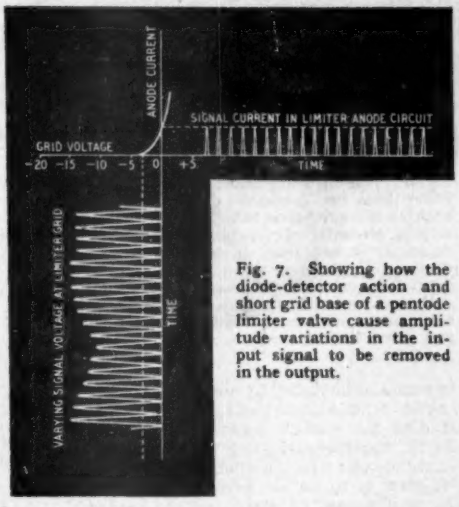


Fig. 7. Showing how the diode-detector action and short grid base of a pentode limiter valve cause amplitude variations in the input signal to be removed in the output.

You will recall that the noise-reducing capabilities of f.m. depend largely on amplitude variations in the signal supplied to the detector being eliminated. This is usually done in the last i.f. valve, a favourite method being to feed that valve with an abnormally low screen voltage. The result is to give it a very small grid base—only a volt or two. The grid is connected as a diode detector, so that the greater the signal amplitude reaching it the greater the negative bias generated by rectification, and the more the signal voltage is pushed down below cut-off. This action is shown in Fig. 7. Provided that the peak-to-peak signal voltage at the grid is never less than the grid base, then, the amplitude of the anode signal current is practically unaffected by input variations, either in the signal itself or as a result of noise or interference.

Seeing that the main idea of f.m. is to provide good reception of signals so weak that in an a.m. system

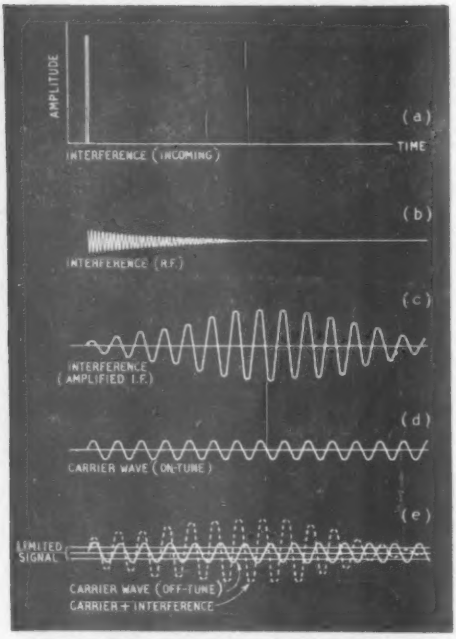


Fig. 8. This sequence shows (though not exactly to scale) how the character of ignition interference changes as it progresses through the receiver, from its original very brief form (a) to a damped r.f. oscillation (b) and an i.f. wave train (c). If the receiver is tuned to the carrier frequency (d) it synchronizes with the interference, which can be removed by the limiter. But if the carrier is mistuned (e), the interference introduces phase (and hence frequency) shifts, which get past the limiter, as shown.

they would be disturbed by noise, there must obviously be a considerable amount of i.f. amplification to ensure that even the weakest signals overload the last i.f. valve in the thoroughgoing manner just described. And at the same time the tuning must not be too sharp —we want it to be flat over about 200kc/s. So it looks as if several i.f. stages will be needed.

Altogether then, by the time an f.m. receiver has been provided with a frequency-stabilized oscillator, several i.f. stages, limiter, carefully designed and adjusted discriminator, de-emphasis circuit, a.f. amplifier and loudspeaker worthy of the wide a.f. band, and probably a tuning indicator and a.f.c, it does not seem likely to come into one of the lowest price classes. But then " ideal " designs never do. If one is content with a reasonably good performance, an f.m. receiver need not differ very much in complication or cost from the corresponding a.m. set.

There is just one other thing I promised to say something about—the effect on f.m. reception of the so-called impulsive noise, which in practice means chiefly motor-car sparking-plug interference. This subject was crowded out of the last instalment and in any case will probably be easier to appreciate now that the f.m. receiver has been reviewed.

The interference from ignition arrives in the form of intense pulses each lasting only a very small fraction of a microsecond (Fig. 8(a)). It cannot get very far through the receiver in this form, because it includes all frequencies from very low up to hundreds of Mc/s, and the receiver is tuned to accept a band only about 0.2Mc/s wide. What happens is that each pulse shock-excites the r.f. tuning circuit into a damped oscillation consisting of quite a large number of cycles. Fig. 8(b) is only a suggestion of this, not drawn to scale. The frequency is reduced by the frequency changer to i.f., which then stirs up the i.f. circuits and is amplified (c). Note that there is no possibility of tuning the interference out, because it takes on the frequency to which the set is tuned. The duration of each train of oscillations, when presented to the limiter and discriminator, is roughly equal to the reciprocal of the overall bandwidth. That may sound rather complicated, but it just means that if the bandwidth is, say, 0.2Mc/s, each pulse train lasts for about $1/0.2 = 5$ microseconds. This is very interesting, because if you have an a.m. receiver and decide that you will take advantage of the much narrower bandwidth of the programme to tune the receiver more sharply, restricting the bandwidth to say 30kc/s (= 0.03Mc/s) with the praiseworthy intention of reducing interference, you find that the pulse trains last $1/0.03$ = about 30 microseconds. Which is not so good. Moreover, if the a.m. receiver has no limiter, the interference is likely to be greater in amplitude, too. Even if you use one of the very cunning limiters that manage to cut off the peaks of noise without distorting the peaks of programme, each spark in the engine messes up the programme for 30μsec. instead of 5μsec. That explains the apparently upside-down policy of the designers who make v.h.f. a.m. receivers much less selective than they need be, in order to reduce interference (assuming of course that the interference is of the untuned type).

But to get back to our f.m. We have seen that the noise pulse trains are arriving bang in the middle of the waveband to which the receiver is tuned. (By " waveband " I mean the band of frequencies accepted by the receiver at any one setting of the tuning control —not the range of wavelengths or frequencies over which it can be tuned by turning the control). If the set is accurately tuned, so that the wanted carrier wave (Fig. 8(d)) is also bang on, the two synchronize, and after the limiter has done its stuff one would hardly know that the interference was coming in. In this way any well-designed and well-tuned f.m. receiver should give considerable protection against ignition. Just as the Egyptian court magicians were able to imitate some of the marvels wrought by Moses, however, a.m. receivers can be produced that will do this particular trick almost if not quite as well.

Now consider what happens if the f.m. receiver is *not* accurately tuned to the programme. The noise trains still come in at the centre of the waveband, but as the carrier wave is now off-centre (Fig. 8(e)) there will be a frequency difference between them. The resulting phase modulation (which of course is a sign of the presence of f.m.) can be plainly seen. So interference is duly accepted by the discriminator and passed on to the loudspeaker. Considered in another way, the noise is equivalent to a powerful side-frequency, which must make itself felt, regardless of the limiter. And that is why I said there were *two* good reasons for making sure that an f.m. receiver was always kept accurately tuned.

Fig. 1. Radio telescope at Cambridge, using two spaced paraboloids to establish a multi-lobed interference pattern.

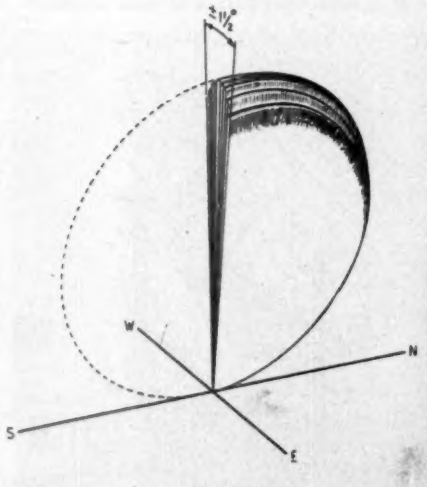
Radio Astronomy

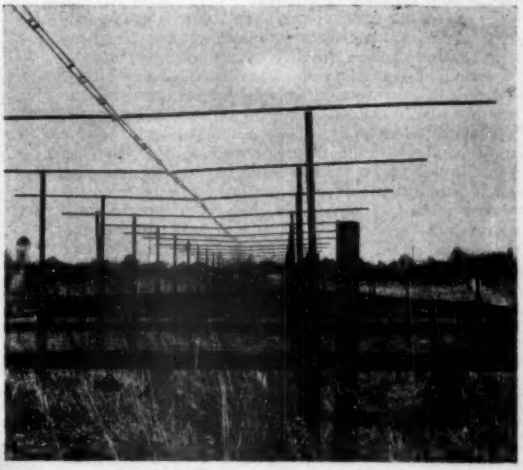
Studying the Cosmos by Radio Methods

HIGH above the South Bank Exhibition, London, on the now famous Shot-tower, is mounted a device that radio engineers will know as a paraboloid and others as a radio telescope, and it symbolizes a comparatively new application of radio in which Britain is at present taking a leading part. This new science of radio astronomy covers a wide range of different activities, makes use of both radar and direction-finding techniques and, as an aid to visual astronomy, has been responsible for a number of remarkable astrophysical discoveries. Most of the important advances have been made in the post-war years with largely ex-Service equipment, so the science owes a great deal to the tremendous improvements wrought by wartime development.

Perhaps one of the most spectacular events in the history of radio astronomy has been the discovery of radio stars. As long ago as 1932 it was known that radio emanations in the form of noise were arriving on this planet from somewhere in space; but no great importance was attached to these findings, even when, later on, aerial systems of improved directivity showed that the signals were stronger coming from some directions than others. Then, in 1948, almost simultaneously from Australia and Britain, came the announcement that a number of very localized sources of emission had been detected, and these have since become known as radio stars.

One great problem in this kind of direction finding is picking out the radio star from the general background of radiations on similar noise frequencies coming from the rest of the galaxy. Obviously a highly directional aerial system is required and, so far, two methods have been tried. One of them uses a large paraboloid to produce a pencil-beam radiation pattern that can be made to sweep the sky like a searchlight, but perhaps the most technically interest-





Left: Fig. 2. Cross-section of a multi-lobed interference pattern set up by the spaced aerial system in Fig. 3.
Right: Fig. 3. Array of stacked dipoles, constituting *one* of the two spaced aerials in an interferometric radio telescope.

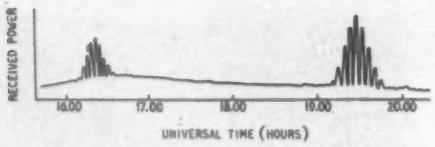
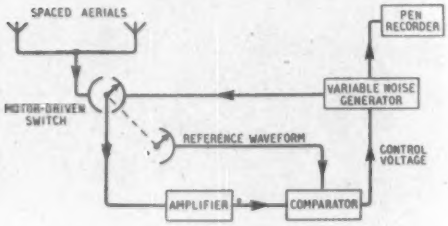


Fig. 4. Part of a record obtained with an interferometric radio telescope, showing two radio stars (in Cygnus and Cassiopeia respectively).

Fig. 5. Block diagram of receiving system used with radio telescopes for measuring small noise powers.



ing is the interferometer type of radio telescope with which most of the original discoveries were made. The British version was built at Cambridge by a team of Cavendish Laboratory workers under the direction of M. Ryle. It consists of two aerials spaced 110 wavelengths apart on a line running East-West (λ is 3.7m), and these, by virtue of the phase differences caused by the two different path lengths, set up between them a multi-lobed interference pattern as shown in Fig. 2. In the North-South direction this beam extends almost from the North Pole to the equator, but its total width is only about $\pm 1\frac{1}{2}$ degrees and this comprises a group of extremely narrow lobes with sharp minima in between.

Thus, as the earth rotates, the beam is swept flatwise across practically the whole of the Northern hemisphere. In the absence of any localized sources of emission—or when the angular diameter of the source is large compared with the lobe separation—the output remains constant or gives only slow variations, but when the envelope is swept across a radio source of sufficiently small diameter the output shows a periodic variation corresponding exactly to the maxima and minima of the interference pattern. A typical record of two such intense sources plotted against time is shown in Fig. 4. It will be seen that the central peak, corresponding to the central lobe of the interference pattern, indicates with great accuracy at what time the centre of the radio star was passed, and from this the right ascension of the star (or "longitude" in the celestial sphere) can be found. The declination (or "latitude") of the star is obtained from the rate of change of path difference to the two aerials. With radio stars near the Pole Star this is slow and tends to spread out the maxima and minima on Fig. 4, whereas with radio stars low down near the equator it is fast and tends to bunch them up together. The declination of the star can therefore be calculated from the time interval between two successive minima on the chart.

Another interesting measurement is the angle subtended by the radio star—from which its diameter can afterwards be calculated. This is obtained from the ratio of the minima to the maxima in Fig. 4, for the "depth" of the minima is really a measure of the smallness of the source. (A large source, subtending an angle greater than about half a degree, will be received by more than one lobe, and will show no maxima and minima.)

Detecting and measuring the signals from radio stars is no easy matter, for they are infinitesimally small. Even with high-gain parabolic or stacked aerials as in Figs. 1 and 3, they are still only about one-thousandth of the noise level of the receiving apparatus! On the face of it the task would seem to be impossible. The method adopted, however, avoids the necessity for taking absolute measurements from the output of the receiver. A local noise generator is continuously and automatically adjusted so that its power output is always equal to that of the aerial, and it is from this that the measurements are made. The arrangement is shown in Fig. 5. One advantage of such a system lies in the nature of the noise generator itself, which consists of a temperature-limited diode working into a resistance load. Since the noise power produced by this arrangement is in direct proportion to the current flowing through the diode, it is only necessary to measure this current with a conventional pen recorder and the result (e.g., Fig. 4) will be a record of the noise power in the aerial. For keeping the noise generator in equilibrium with the aerial, a motor-driven switch samples each in turn and feeds the result into an amplifier; then, if the powers are not equal, the output of the amplifier will contain a waveform at the sampling frequency whose amplitude is a measure of the unbalance. This is selected by a filter and compared with a reference waveform (generated by the switch-motor shaft), and the resulting "error signal" is used to control the noise generator towards equality. It will be noted that the system is independent of the gain and frequency response of

Steerable paraboloid used as a radio telescope at Jodrell Bank Experimental Station. The dipoles at the focus can be changed for working at different frequencies.

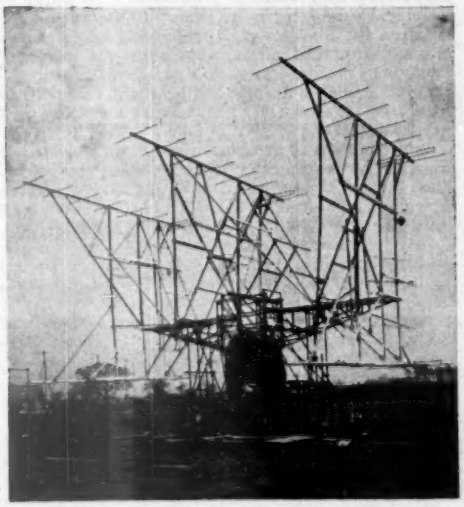
the amplifier, and the sampling frequency is sufficiently fast to prevent fluctuations in gain from upsetting the comparison.

Using such methods, the Cambridge workers have discovered and plotted about 50 radio stars in the Northern hemisphere, while the Australians have accounted for a similar number in the Southern hemisphere. It seems likely that these hundred or so are the most intense of a large number of radio stars distributed throughout the galaxy in a similar manner to the distribution of visual stars. So radio astronomy may well provide a further means of studying the actual structure of the galaxy, especially those parts which are for ever obscured from view by large clouds of interstellar dust. Nobody knows what radio stars are, but the most probable suggestion is that they are normal stars in the process of formation, and that this is responsible for the generation of electromagnetic waves. At the Jodrell Bank Experimental Station of the University of Manchester, workers are using the pencil-beam technique with a huge 218-ft paraboloid, and one of their principal discoveries has been a radio source in Andromeda—a galaxy outside our own and 750,000 light-years away!

Similar techniques are being applied to the study of the sun and sunspots, and to finding the polarization of the received waves. Another interesting subject is the "twinkling" of the radio stars. Since the effect is caused partly by refractive disturbances in the ionosphere (as well as by fluctuations at the source), radio astronomy is providing a valuable means of studying this region—and it has the advantage over radar that the waves are coming right through instead of being merely reflected from the bottom surface.

Another interesting branch of radio astronomy is the study of meteors, or shooting stars, and here radar comes into the picture as a means of determining such factors as range, velocity and direction. To an outsider this work may seem of little practical value, but in the world of astronomy the radar observations

Fig. 6. Radar aerial array mounted on a searchlight, for meteor observations at Jodrell Bank. Each radiator is a folded dipole with six directors and a reflector.



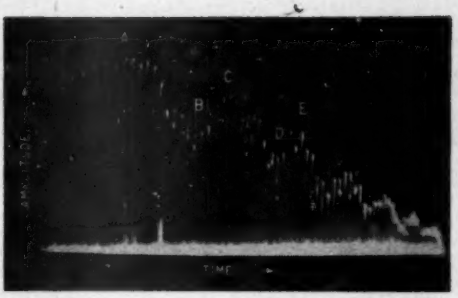
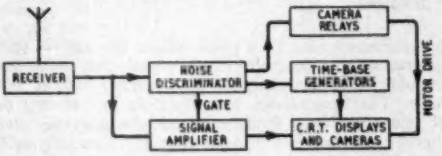


Fig. 7. Successive radar pulses returned from the meteor trail as it crosses the radar beam. Transmitter p.r.f. = 1,000 per sec; time-base = 0.1 sec; meteor velocity = 34 km/sec.

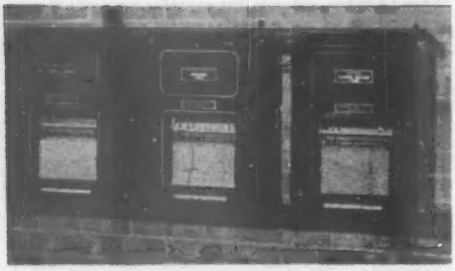
Fig. 8. Block diagram of automatic meteor recorder.



have already provided much valuable information that could never be obtained visually, and have settled at least one age-old controversy. Briefly, there have been two hotly opposed schools of thought on the origin of the meteors, one saying that they are confined to orbits in the solar system and the other that they are visitors from interstellar space. The vital information required to clinch this argument is a knowledge of the meteor velocities, and various attempts have been made to measure them optically—not, however, with very much success.

Although the meteors are actually about the size of a pin-head and enter our atmosphere at somewhere in the region of 100,000 m.p.h., their rapid burning-up leaves behind an ionized trail of up to six miles in length, and this makes a very effective reflector of radio waves. J. S. Hey, a pioneer in all branches of radio astronomy, first used radar in 1946, and his method was to take two spaced observations on a meteor, measure the time interval and so calculate the velocity, but this did not lead to very conclusive results. In 1948, however, a new and interesting method was brought forward by workers at the Jodrell Bank Experimental Station, under the direction of A. C. B. Lovell, and this has led to the construction of a recording apparatus which is automatically triggered by the meteors themselves, whenever they arrive, and leaves all the data necessary for velocity calculations recorded on films.

An essential of this new method is that the meteor trails shall form across the radar beam at right angles, and for this reason the Yagi aerials are generally "aimed" horizontally (Fig. 6) to encounter meteors falling vertically. With the aid of a slow single-stroke time-base the first fifty or sixty echoes from the trail are displayed in a line and the result is as shown in Fig. 7. Now the periodic variation in amplitude here is caused by phase changes resulting from different echo-path lengths as the meteor extends its trail across the radar beam. As the meteor passes the normal of the radar beam, the echoes rise to a maximum A,



Above: Group of pen recorders measuring various radio sources at Cambridge.

Right: Automatic meteor recorder for making a continuous photographic record of two c.r.t. displays. The camera is underneath the sloping panel and can be lifted out.

but it comes next to a point where the echoes from its trail will be returning down a path that is *one half wavelength longer* than the right-angled path or normal. The new echoes will therefore be 180 deg out of phase and will tend to cancel the previous ones, thereby producing a minimum at B. Similarly at C, D and E, so that the time intervals measured between AB, BC, etc., have only to be associated with the corresponding distance intervals (between the "half-wave path difference" points) to give the velocity of the meteor. These distances are obtained by continuously measuring the range on another c.r.t. time-base and, with a knowledge of the wavelength, forming triangular problems in which they are the unknown side. In practice, a fairly simple formula gives the velocity direct from the measured data.

The automatic recording apparatus, therefore, contains two time-base displays fitted with cameras: a single-stroke one (0.1 sec)—triggered by the meteor echoes themselves—for producing records as in Fig. 7, and a faster one (7 millisec)—showing the first few echoes in relation to the transmitter pulse—for recording ranges. Fig. 8 shows the essentials of the equipment. Echo pulses from the receiver (a conventional superhet) pass into a discriminator which separates genuine echoes from random noise impulses by virtue of the fact that the latter are generally of much shorter duration than the 8-16μsec radar pulses. It therefore works as a "gate" on the signal amplifier, and only allows the genuine echoes through to the c.r.t. display—where they are immediately photographed. In addition, the discriminator serves to trigger the time-bases of the displays upon arrival of a meteor—and to actuate a relay system which starts the camera motor and blanks out the c.r.t. trace until the next film frame is in position. There is also a suppression system, of course, to render the receiving equipment inoperative during a transmitter pulse.

With the aid of such apparatus, the Jodrell Bank workers have made a number of remarkable discoveries. First of all, they have settled the astronomical argument in favour of those who believe that the meteors originate in the solar system. Then they have found that the sporadic shooting stars seen at night are not the only ones, but that vast showers occur in the day-time—when, of course, radar is the only means of observation. In fact, they estimate that some 8,000 million meteors enter our atmosphere every day. As to the origin of the meteors, the observations seem to indicate that the night-time showers are caused by this earth passing through the trails of comets, and this was strikingly demonstrated in 1946 when the Giacobini-Zinner comet passed within 15 days of us (a very close shave, astronomically speaking!) and the recorded meteoric activity went up about 5,000 times. The day-time showers, however, do not appear to be associated with comets, and it is possible that they are actually debris produced by disintegration of some of the minor planets.

South Bank Radio Telescope

The radio telescope at the South Bank Exhibition is being used to detect both solar and galactic noise and this, after amplification, is presented to the public in visual and aural form in the Dome of Discovery. The aerial on the Shot-tower (a wide-band folded dipole with a 30-ft paraboloid) is swept across the sources of emission by means of a remotely controlled gun mounting and, at the same time, the resultant variations of signal level are shown on a pen recorder and reproduced on a loudspeaker.

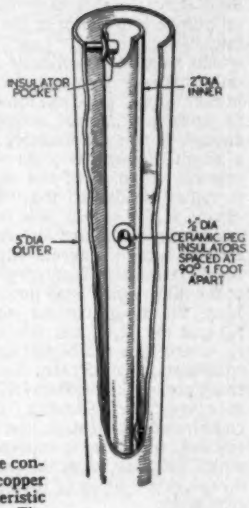
At the bottom of the Shot-tower and connected to the aerial by coaxial cable is the receiving equipment. This, however, does not utilize the kind of system shown in Fig. 5—merely a 120-Mc/s superhet of high sensitivity and stability and low noise level (makers, Leland Instruments). An important part of it is the low-noise pre-amplifier, which has a 6AK5, triode-connected and neutralized, coupled in cascode to a single earthed-grid section of an ECC91 double triode, the third stage being another earthed-grid ECC91 section (see *Proc. I.R.E.*, June, 1948, page 700). From here the signals are fed to the receiver proper, the output of which divides into two channels, the first passing via a filter to a d.c. amplifier and the pen recorder and the second going through an a.f. amplifier to the loudspeaker. Stabilized h.t. supplies are used, while the valve heaters are supplied by a battery of secondary cells which are charged at the same rate as the current is being consumed.

Wrotham Aerial System

(*Concluded from page 214 of the previous issue*)

2.—The Main Transmission Line and the A.M./F.M. Combining Filter

By C. GILLAM *



The main transmission line consists of two concentric copper tubes with a characteristic impedance of 51.5 ohms. The spacers are ½-in dia Frequentite rods.

It was explained in the first part of this article how a slot radiates and how a number of slots can be arranged to produce a high gain omni-directional radiator; also, the problems involved in distributing r.f. power to a multiple-slot radiator were discussed. In this part, the transmission line which conveys r.f. power to the distribution system is described and an explanation is given of the method adopted at Wrotham to enable an f.m. and an a.m. transmission to be radiated simultaneously from the single aerial system

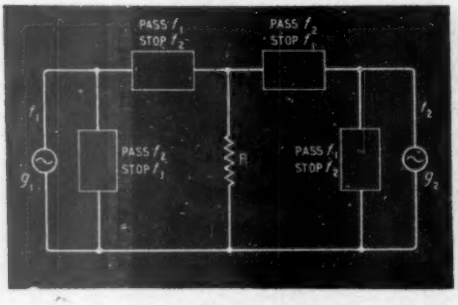
THE main transmission line is of the same general design as that used at Sutton Coldfield. It has an outer conductor of copper tube with an internal diameter of 5in and an inner conductor of copper tube with an external diameter of 2.128in, giving a characteristic impedance of about 51.5 ohms. The spacers are ½-in diameter Frequentite rods inserted radially in pockets let into the inner conductor; there is one such rod every foot of length, successive rods being shifted relatively 90 deg around the inner conductor. Because of the rather high frequency, very great care was needed to match out all impedance discontinuities at angles, expansion joints, etc., but eventually the standing-wave ratio due to reflections in the line itself when terminated in its characteristic impedance was less than 1.03 over the whole band from 87.5 Mc/s to 95 Mc/s. The measured attenuation of the line is 0.65 db at a frequency of 95 Mc/s. Due to site exigencies, the main transmission line has to follow a rather circuitous route on the ground, so that although the height to the centre of the slot system is only 405ft the total length of the line is about 727ft. The measured attenuation thus corresponds to an average attenuation factor of 0.09 db per 100ft of line including all angles, expansion joints, etc., which is very close to the theoretical figure for a plain copper line with no insulation losses.

The standing-wave ratio measured at the input end of the main transmission line when terminated by the complete distribution feeder system and slot radiator was less than 1.1 over each of the two ranges. This result is interesting, since apparently the standing-wave ratio of the distribution feeder system and radiator is not degraded by the interposition of the transmission line. In fact this is not so, and the effect is accounted for by the attenuation in the main transmission line; see Appendix II for a further explanation.

The object of this filter is to enable two separate transmitters, working on different frequencies, to deliver their power into the common load which consists of the main transmission line terminated by the slot radiator. It is necessary that each transmitter should "see" a resistive load of the correct value, and that to avoid cross-modulation a negligible proportion of the output power of either transmitter should reach the output terminals of the other. The problem is rather similar to the "diplexing" of vision and sound transmissions at Sutton Coldfield, but the solution adopted there, involving a relatively simple balanced bridge "diplexer," also required two transmission lines from the transmitter hall as well as a load divisible into two equal parts and susceptible to feeding in parallel or push-pull.

At Wrotham the load cannot be divided in this way, but fortunately the band-width required for each transmission is comparatively narrow, and it is possible to use a "notch" type filter. The principle of operation of such a filter is shown in Fig. 6, where

Fig. 6. Principle of the combining filter, rectangles represent the lumped reactance structures.



* Marconi's Wireless Telegraph Company

g_1 and g_2 are generators and the rectangles represent lumped reactance structures with the impedance characteristics indicated. If these reactances were absolutely lossless, they could be made to exhibit an infinite impedance in the "stop" band, and a zero impedance in the "pass" band. In that case, it would have been sufficient to employ series elements only. However, practical components are such that in the "stop" band the impedance is not great enough to prevent a current flowing which would be large enough to cause appreciable interference. Accordingly a shunt element is used which has characteristics opposite to those of the series element. The effect is rather similar to that of an ordinary smoothing circuit at the output of a rectifier, where series high reactances and shunt low reactances are used alternately in order to prevent alternating currents reaching the d.c. circuits. Figure 7 shows a practical realization of the filter, again using lumped reactance components. Here the L_1C_1 circuits anti-resonate at frequency f_2, and the L_2C_2 circuits anti-resonate at frequency f_1, where f_2 is the higher frequency. At f_1 the L_1C_1 combination is off tune, and appears as an inductive reactance, which resonates with C_2, the whole appearing as a very low resistance. Similarly at f_2 the L_2C_2 combination is off tune, but since f_2 is above the anti-resonant frequency it appears as a capacitive reactance which resonates with the inductance L_4. Figs. 8 and 9 explain the action of the filter at the two frequencies separately.

The reason for describing a circuit of this type as a notch filter is clear from Fig. 10, which shows how the current in R varies when generator g_1 is replaced by a variable frequency generator of constant e.m.f. with some internal impedance. As the frequency increases from zero, the current rises to a peak at f_1 the "pass" frequency, falls in a sharp "notch" at the "stop" frequency f_2, and then slowly climbs again towards the maximum value. If the same characteristic were measured on the g_2 side, the result would be rather similar, except that the current would be large at low frequencies, and would tend to zero at frequencies above the "stop" and "pass" values.

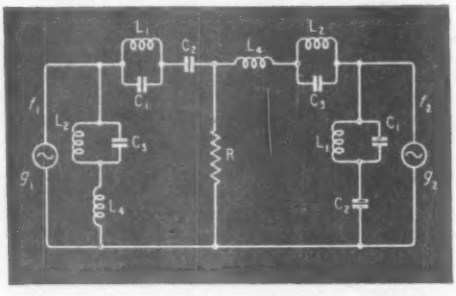


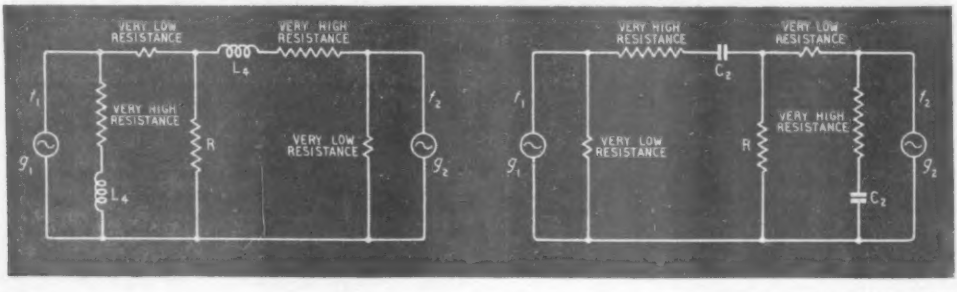
Fig. 7. Practical form of a combining filter including series and shunt elements and using lumped reactance components.

Below Left: Fig. 8. Combining filter as shown in Fig. 7 as it appears to transmitting frequency f_1. Below Right: Fig. 9. The filter of Fig. 7 as it appears to the alternative frequency f_2.

Transmission Line Filter

It is readily possible to construct a filter which operates in a very similar manner, but in which transmission line elements are used in place of inductors and capacitors and the Wrotham combining filter is of this type. Consider Fig. 11 where AB is a twin-wire transmission line. Two stubs, a short-circuited one CD and an open-circuited one CE are shunted across the line at C. CD is half a wavelength long at f_1, and consequently its input impedance is equal to its termination impedance, namely zero. That is to say, at f_1 CD behaves as if there were a short-circuit across the line at C, and hence any energy at frequency f_1 reaching the junction C is completely reflected towards its source. Frequency f_2 is a little higher than f_1, so that at f_2 CD is greater than a half wavelength long. The shorter stub CE makes the total length DCE three-quarters of a wavelength at f_2. Under these circumstances CD looks like an inductive reactance and CE like a capacitive reactance of exactly equal magnitude. The two stubs therefore resonate as a whole and appear at C as a high-resistance shunt. Thus energy at frequency f_2 is not impeded, but a small proportion is abstracted to make good losses in the stubs.

In Fig. 12 there is a similar situation, the thick line AB representing the inner conductor of a co-axial transmission line. CD and CE are co-axial stubs, and the convention is used here and in subsequent diagrams of a short bar at the end of the stub to indicate a short-circuit, and a small o to indicate an open-circuit. The thin line parallel to AB represents the r.m.s. voltage on the line at frequency f_2, for which the source is somewhere beyond B. Since the line is assumed to be correctly terminated at some point beyond A there is no standing wave on it. At C this voltage is applied to the two stubs, and it sets up on them the voltage standing wave shown. It is to be noted that the maximum amplitude of this standing wave is greater than the r.m.s. main line voltage. Fig. 13 shows what happens to transmission f_1,



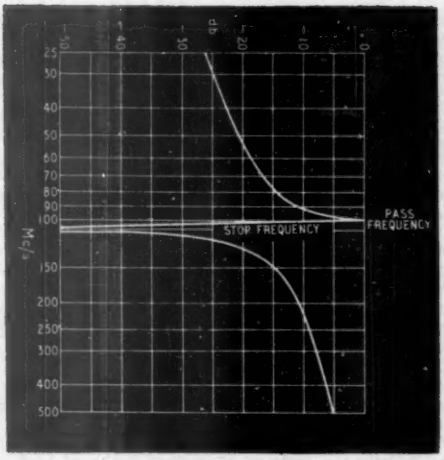
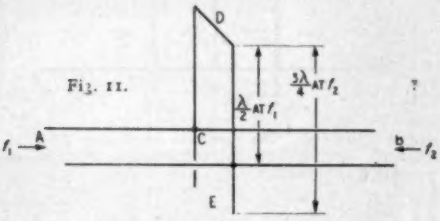


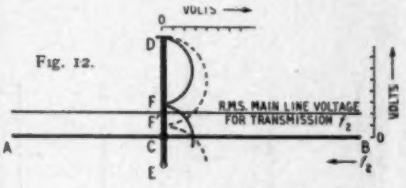
Fig. 10. Curves showing the insertion loss of the combining, or "notch," filter.

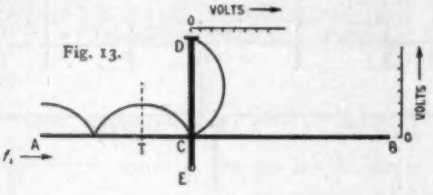
arriving from the direction of A; the "virtual" short-circuit at C sets up a standing wave on the main line, which is a continuation of that on the stub CD, with voltage nodes every half wavelength back from C. In Fig. 14 there is shown another section of line GH with two short-circuited stubs, JK and JL shunted across it at J. JK is an exact half-wavelength at frequency f_2, and it behaves for that frequency exactly as does CD in Fig. 13 for f_1. At the latter frequency JK is less than a half wavelength long, and it is built out to a half wavelength by the short stub JL. The thin line parallel to GH on Fig. 14 now represents the r.m.s. voltage at the frequency f_1 from a source to the left of G, the line being assumed correctly terminated to the right of H. An exact half-wave standing wave is set up on LJK and again the maximum value is greater than the r.m.s. main line voltage. As in the previous case for f_2, the f_1 transmission is now unimpeded but there is a small energy loss in the stubs.

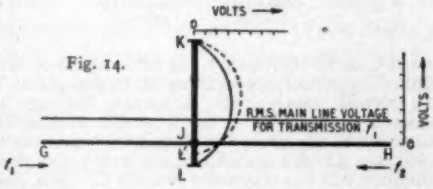
Before leaving Figs. 12 and 14 it is necessary to consider the effect of the amount of the frequency difference between f_1 and f_2. In Fig. 12 the half wavelength at frequency f_2 extends on DC from D to F, while there is a quarter wavelength from F through C to E. If f_2 had been closer to f_1, F would have been nearer to C at F' so that F'C would have been a smaller part of the wavelength. The voltage at C would still have been the same, but the standing wave would have had a greater amplitude, as indicated by the broken curve. This greater amplitude would have involved a greater power loss in the stubs. In Fig. 14 the situation would have been rather similar, since for a smaller frequency difference JL would have been shorter, say JL' and again the standing wave would have had a greater amplitude. Circumstances may be such that a stub designed on these lines is impracticable, either because of the high voltage of the standing wave, or because the stub abstracts too much power from the transmission, or just because the losses in the stub are so great that the resultant heat is an embarrassment. All of these difficulties are eased by making the short-circuited stub two, three or even more half wave-

Fig. 11. Twin-wire transmission line with one open-circuit and one short-circuit stub. Fig. 12. Similar arrangement as shown in Fig. 11, but for co-axial transmission line and stubs. Fig. 13. The line and stubs of Fig. 12 as it appears to frequency f_1 for which the stub DC = $\lambda/2$. Fig. 14. Two short-circuited co-axial stubs to block f_2, for which KJ = $\lambda/2$ and to pass f_1, for which KL = $\lambda/2$.





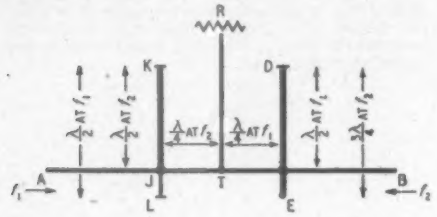




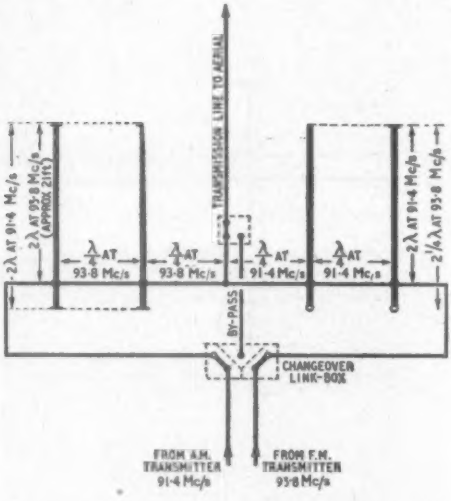
lengths long at the "stop" frequency, instead of only one half wavelength as in Fig. 13. The effect of doing this is to multiply the length FC in Fig. 12 or JL in Fig. 14 by the same factor, so that the standing-wave amplitude is equal to the line voltage at a point nearer its maximum, and in consequence the maximum itself is less. There is, unfortunately, a concomitant disadvantage, since at the "stop" frequency, the virtual short-circuit on the main line is not so good as before, and a small proportion of the energy gets past it.

On Fig. 13, T is a point on the main line one quarter wavelength at f_1 back towards the f_1 generator from the stubs CD and CE, and it is therefore at a maximum of the f_1 voltage standing wave. If we were to cut the line at T and measure the impedance looking

Fig. 15. Combining filter with co-axial elements for two transmissions, f_1 and f_2, built up with the stubs of Figs. 12 and 13.



Below: Fig. 16. The complete combining filter as used at Wrotham constructed from co-axial transmission line elements.



toward C at the frequency f_1, its value would be very high. The virtual short-circuit at C appears at T as a virtual open-circuit. A branch line can be connected at T and if it has a correct termination, practically all the energy at frequency f_1 arriving at T will pass into this branch line, and only a very small proportion will be transmitted towards C. It is clear that we now have a transmission line system which behaves in an analogous manner to the lumped reactance networks of Fig. 7. A complete filter on these lines is shown in Fig. 15, which makes use of one pair of stubs from Fig. 12 and one pair from Fig. 14. This form of filter would be quite satisfactory provided that f_1 and f_2 were not too close together.

At Wrotham, the two transmissions have frequencies which differ by only about two and a half per cent, the a.m. transmission being at 91.4Mc/s, and the f.m. transmission at 93.8 Mc/s. In order to reduce the voltages and the losses in the stubs to an acceptable value at the "pass" transmission frequency, it has been necessary to make them two wavelengths long at the "stop" frequency. Then, in order to ensure the specified degree of separation between the two transmissions, a further set of stubs has been put on each line at points a quarter of a wavelength nearer to the transmitters (Fig. 16). These additional stubs also have the effect of compensating for the impedance discontinuity introduced by the first stubs, so that in the pass-band the filter presents only a very low standing-wave ratio to the two transmitters. In fact the measured standing-wave ratio on the a.m. branch is better than 1.03, and on the f.m. branch it is indistinguishable from unity. The insertion loss of the complete filter measured from one transmitter branch to the other with the output transmission line connected is considerably in excess of 60 db, this being the limit which could be measured with the available apparatus. This means that of the 25 kW of the f.m. transmission, considerably less than 25 milliwatts reach the a.m. transmitter. For both transmissions the insertion loss in the pass-band is of the order of 0.25 db, which corresponds to a loss of about 1,400 watts from the f.m. transmission, and a little less from the a.m. transmission. This power appears as heat in the stubs, and in order to keep their temperature to a reasonable value, air is continuously blown through them.

The filter is built up entirely from standard 5-in transmission line tubes and junction boxes. Because of the very high voltages on the stubs the inner conductors of these are supported only at points very near to the voltage nodes, and these supports are large conical Frequelex insulators fitted in special cast boxes. A by-pass with link boxes is installed, so that the transmission line from either transmitter can be connected directly to the aerial transmission line with the combining filter out of circuit.

Editorial Note

With reference to the footnote on page 211 in the June issue, it should be noted that the general design of the slotted cylindrical aerial and the development of the wide-band folded slots resulted from original work by the B.B.C. Research Department. The slot feed and reactance compensation system is the subject of a B.B.C. patent application No. 677/49.

APPENDIX II

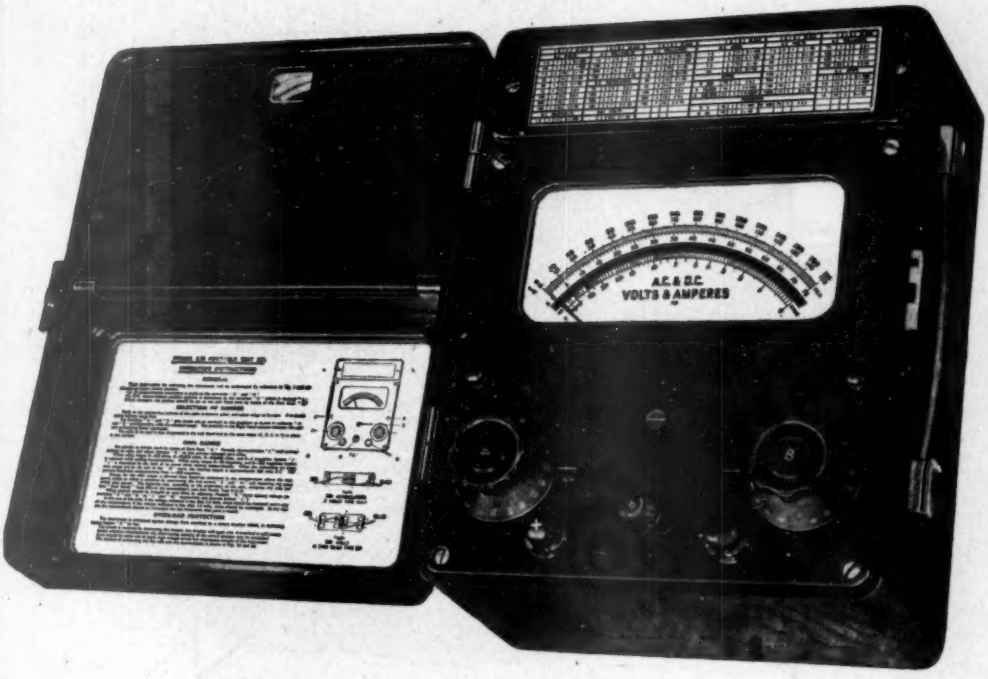
Effect of Line Attenuation on Standing-wave Ratio

Saying that a particular load produces a standing wave on a transmission line means that it causes a proportion of the forward wave reaching the load to be reflected back towards its source. Now the forward wave in travelling from the source experiences attenuation, that is, its amplitude is greater at the input end of the line than at the load. The reflected wave, travelling backward, has a greater amplitude at the load (which behaves as its source) than at the input end of the line. So the ratio of reflected wave to forward wave is smaller at the input end than at the load, and the standing-wave ratio is correspondingly reduced. The reduction is readily calculated, as follows.

Let the line attenuation be α db, then the corresponding voltage amplitude ratio is $m = 1/\text{antilog}_{10}\frac{\alpha}{20}$ (where $m<1$). If the standing-wave ratio at the load is S_l, $(S_l>1)$, then the reflection factor at the load is $r_l = (S_l-1)/(S_l+1)$. That is, S_l is accounted for by a forward wave of unity amplitude, and a backward wave of amplitude r_l.

Because of the line attenuation, the forward wave must have an amplitude greater than unity at its input, actually $1/m$. Similarly the backward wave is attenuated and its amplitude becomes mr_l. Finally, the input standing-wave ratio is :—

$$S_i = \frac{1/m + mr_l}{1/m - mr_l} = \frac{S_l(1+m^2)+1-m^2}{S_l(1-m^2)+1+m^2}$$



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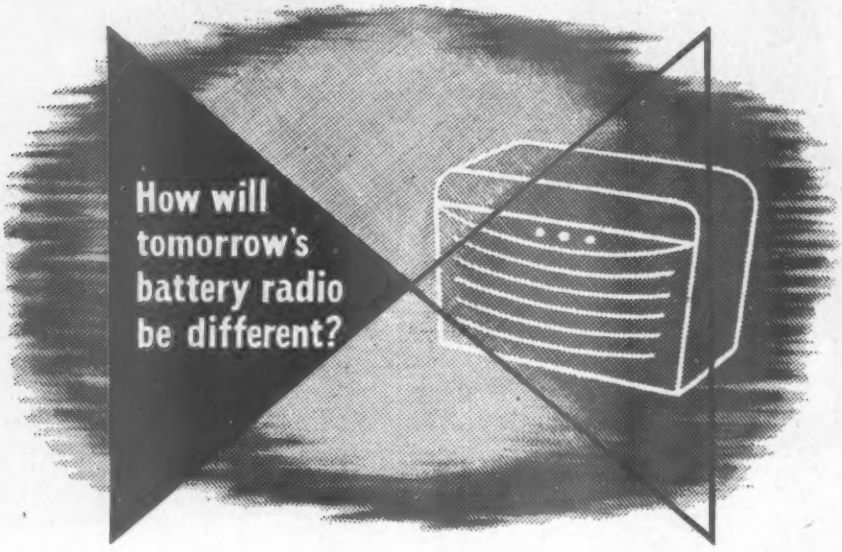

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Recording on Tape

Some of the More Prevalent Causes of Indifferent Results

By R. W. LOWDEN*

THE general theory and technique of magnetic recording have already been covered in this journal[1], and it is proposed in this article to give some further practical hints which may save the experimenter a few headaches and disappointments.

The layout of a tape recording machine will depend essentially on three factors: performance, size and cost. The desired performance puts immediately a lower limit to the size of the machine and its cost. If a frequency response of up to 7,000 c/s is required it will be found necessary to run the tape at a speed of at least 7½ inches per second. If, however, the tape is run at 15 inches per second it will be found to be much easier to achieve a flat response up to 7,000 c/s with a substantially good response up to at least 10,000 or 12,000 c/s, but both the cost and volume of the recording medium used will be immediately doubled.

One of the most important things when contemplating the design of a tape recorder is to have a clear idea of the performance required in terms of the importance to be given to the three vital factors of frequency response, signal-to-noise ratio, and distortion. These are all very closely interdependent.

All too often a wide frequency response is made the prime aim, and in spite of its achievement the results are found to be very disappointing. It is generally better to restrict the range at the upper end and give more weight to the other two factors.

Experimenters in this fascinating branch of sound recording fall into three classes: first, those who will wish to make the whole recorder from start to finish and have a good knowledge of mechanics and electronics; second, those who have not the facilities or skill for mechanical construction but can cope with the electronics; and third, those who will purchase a complete commercial machine and confine their experiments to the actual art of recording.

To the first class, it is suggested that a careful study of the mechanical principles involved is just as important as a thorough understanding of the electronic requirements; indeed, the two are interdependent, and time spent in really knowledgeable planning will pay handsome dividends in the overall results achieved. The main decisions to be made at this stage are the maximum continuous playing time and the tape speed or speeds, as both these affect the spool size, motor and final capstan speeds and capstan diameter, as well as the general layout and overall size of the tape deck. Consideration must also be given to such things as braking, location of heads, pressure pads and capstan jockey wheel actuating mechanisms, and also any interlocking devices which may be thought necessary. Remember also that the tape speed will affect not only the frequency response but also the equalization required for correct playback.

Hum

At the low-frequency end of the scale hum is the biggest problem, since, assuming the conventional constant-current recording characteristic, the signal output from the tape is of a comparatively low order. Great care is therefore necessary if a signal-to-hum ratio of better than, say, 45db is to be achieved. It is of great assistance to use a transformer between the head and the first valve of the playback amplifier, in order to lift the signal well above the amplifier hum and noise. This arrangement will, of course, give no improvement in the hum induced into the head, but this is a matter of careful screening and correct positioning of components.

It must be remembered that the transformer has to match an inductance and not a resistance, and in deciding on the optimum ratio one must take into account the fact that the impedance from which it is working varies with frequency.

To assist in the reduction of hum it is helpful if the hum-producing and hum-sensitive components can be orientated so that their windings are in the most favourable position for low hum pick-up. In this connection the magnetic hum pick-up in the first valve cannot be ignored.

If it is desired to work the first valve's heater from a.c. supply a type with a bifilar heater should be chosen, such as the EF37A or the EF40, the latter being particularly good for this position. A clear distinction should be made, however, between orientating components for minimum hum pick-up or generation, and orientation to pick up such a value of hum as to be in anti-phase with that induced in other parts of the circuit, i.e., "hum bucking."

Whilst this "hum bucking" may be a satisfactory solution from the amateur's point of view when a single model only is being constructed, it must be avoided in any large-scale production, as its effect is by no means constant and, moreover, it is usually only possible to balance out the fundamental, leaving the much more objectional harmonics still present.

Motors can also be a source of large hum generation due to leakage from the field. Normally a special lamination and winding arrangement is necessary to

* Hon. Sec., The British Sound Recording Association.

[1] "Magnetic Recording," G. L. Ashman, August 1944.
"The German Magnetophon," R. A. Power, June 1946.
"Magnetic Recording Technique," D. Roe, October 1949.
"Magnetic Recording Tape," H. G. M. Spratt, March and April 1951.

cut this down. Again, with squirrel-cage asynchronous motors, rotor ripple may be objectionable if the head screening is insufficient. Because of the slip frequency in the rotor this sometimes causes a hunting note as it is obviously not exactly in phase with the supply mains.

"Wow and Flutter"

In the actual construction of the whole tape transport system it cannot be too emphatically stressed that only the best possible standard of workmanship will suffice. Anything short of this will produce "wow" and "flutter" to a marked degree. It is not a simple matter to transport a tape *at a constant linear speed* across the recording and reproducing heads, and however good may be the "electronics" they will not make up for poor workmanship in this direction.

On the question of tape drive, "wow" is the great enemy, and getting it down to very small proportions is an extremely difficult task. Here again there is a choice between several evils. Low-speed, large-diameter flywheels are good from the "flutter" point of view, but are inclined to have cyclic "wows" at flywheel speed, i.e., low frequency. High-speed, small-diameter drive systems overcome this fault, but are liable to "flutter" symptoms at around 25 c/s unless they are very accurately made.

Normally it is necessary, before assembly, to grind all essential peripheries on their own spindles and bearing assemblies. It must also be remembered that the tape transport mechanism has, first, to provide a constant linear speed drive for the recording and reproducing functions and, second, to provide a high-speed drive in both the forward and rewind direction for ease in editing the tape. The first function requires adequate flywheel effect and mechanical filtering to overcome the irregularities in the motor torque caused by "cogging," etc., whilst in the second requirement the flywheel effect should be kept to a minimum to cater for the very rapid change of speed.

On the electronic side, by far the simplest approach is to have two separate channels for the record and playback operations, feeding into separate heads, with a third head fed from an oscillator for purposes of erasing. This method will avoid the complicated switching circuits which must be used with a combined record-reproduce head, and will ease the design from the point of view of screening and general layout of component parts. Another great advantage of the three-head system is that, as reproduction is possible immediately following recording, it is easy to make alterations in the recording characteristic and note the results without the necessity of having to rewind before reproducing. This facility alone is well worth the slight extra expense needed for the second channel. Even when the final characteristic has been decided upon it is valuable to be able to monitor the actual programme without having to rely on the modulation meter as the sole indication of a successful recording, only to find that there is nothing on the tape!

Head design is almost a science in itself. Generally speaking, recording and playback heads should be made from high-permeability nickel-alloy laminations of the thinnest possible cross-section to reduce eddy current losses, and as much work as possible must be done on them before they are heat treated. Then they must be handled with care and finished by only the lightest grinding and polishing.

In order to arrive at a very narrow effective magnetic gap, approaching that of the physical gap, it is necessary to grind and polish the faces very carefully. When one gets down to the order of 0.00025 in physical, an effective gap of 0.00033 in can usually be obtained by hand honing of the butting faces. The depth of the butting faces to be left can be approximately 0.04 in, which will allow a good running life before serious change of the characteristics of the head sets in.

With narrow gaps of this order, however, intimate contact must be maintained between the tape and the head. Pressure pads materially assist here, although the pressure must not be too great or wear will be unduly heavy.

In order to cut down the hum introduced into the head, copious screening with Mumetal is desirable, leaving only the smallest possible slit for the entry of the tape. In one well-known make of recorder a Mumetal wing is placed over this gap after the tape has been inserted, to distort the field in this vicinity so as further to reduce hum pick-up.

Heads can be wound of any reasonable impedance, provided that the oscillator and feed arrangements are matched to them. The oscillator itself must have a pure and symmetrical waveform, particularly in respect of second harmonic, as this has the same effect as a direct-current polarizing field, which will give a high background noise. Direct-current components must be eliminated from the head while recording, and where connection is made from the anode of a valve, the isolating capacitor must be of a very high quality.

On the question of the oscillator for erasure; the usual frequency is approximately 45 kc/s and is often obtained by the use of a single 6V6 valve. With care this is quite a satisfactory arrangement, but there is no doubt whatever that a much better waveform can be obtained by the use of a small oscillator valve feeding a small power valve, both valves working well within their particular limits. If the waveform of the self-excited 6V6 valve is not pure, and it very rarely is, then the tape will leave the erase head with a small amount of background noise, as mentioned above. The use of a power valve with a degree of control of output will ensure a really clean erasure and a more flexible control which will be found useful when experimenting with tapes requiring a higher erasing current.

Recording Characteristic

Regarding recording characteristic, here again the end use of the equipment determines largely what can be done. Where only speech is to be used advantage can be taken of a weighted frequency response, e.g., the high frequency end can be given some pre-emphasis before recording. This is, however, not always possible in cases where the recorder is to be used for noise analysis, where the same spectrum distribution does not hold good. In the former case, however, a 6 db pre-emphasis at 10,000 c/s, based on 1,000 c/s, can be safely adopted, as some of this will be employed in overcoming the head losses, which increase with frequency. It is generally preferable to adopt a constant-current characteristic, with sufficient pre-emphasis to overcome head losses in the recording chain, and to arrange for any bass- and treble-tilting circuits to appear in the reproducing amplifier, where they can be usefully employed in

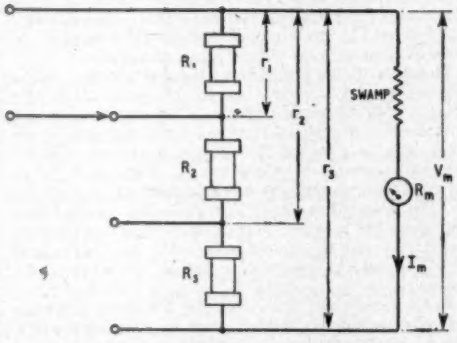
compensating for room acoustics, personal preference, etc.

During the past six months the constructor has been better looked after than previously as regards availability of suitable tape for recording at the lower speeds of 7½ and 3¾ inches per second. At least three makes of high-coercivity taps are available in this country at around 35s per reel of 1,200 ft. It is necessary to warn the user that he should look carefully for any tape which has a number of pieces joined together to make up the usual 1,200 ft reel. In some cases, where faulty tape has escaped the notice of inspection departments, the difference in response obtained on the various pieces in one reel have varied by as much as 3 db and the user should make sure that he is not being led astray in his experiments by the use of such tapes.

In conclusion the author acknowledges gratefully the collaboration of E. H. Niblett, E. B. Angold and J. W. Clarke in the preparation of this article.

Universal Meter Shunt

Avoiding Switch Contact Errors in Multi-range Instruments



Connections of a universal shunt.

THE common form of high-resistance universal shunt is very useful with a high-resistance galvanometer, but for permanent use with a low-resistance and low-range milliammeter to extend its range the universal shunt has to be designed to suit the resistance of the individual instrument. The great advantage of the universal shunt in this application is in the avoidance of switch or other contact errors. In this circuit the shunts are permanently connected, preferably by soldered joints, and the external connections made either by terminals or a switch in which any variation in contact resistance makes a small difference to the circuit resistance but none in the instrument circuit.

To eliminate temperature error it is essential for the movement to have a swamp of Eureka or other low-temperature-coefficient wire in series with it. If the milliammeter has no internal shunt it may not have a swamp and this should be added externally: the swamp resistance should be about three times that of the movement.

The calculations are given for a typical case of three ranges, I_1, I_2 and I_3, but the method can be extended as required. I_3 is the lowest range, and it must exceed the range of the instrument, preferably by a factor of not less than 1.5. Thus an instrument of 1 mA range would have its lowest of three ranges 1.5 mA. All the shunts are connected in series and directly across the movement and swamp; thus when the I_1 or highest range is in use the other two shunts act as extra series resistance in the movement circuit. This means that if the terminal volt drop is the standard 0.075-volt (75 mV) the drop across R_1, the shunt corresponding to the range I_1, will exceed this amount. The resistance of the movement and swamp is called R_m, and the current through the movement at full-scale deflection I_m, with V_m as the voltage drop across the movement, R_m. V_m then equals $I_m \times R_m$.

In order to calculate R_1, R_2 and R_3, other subsidiary terms are necessary, r_1, r_2 and r_3, where, as seen in the Figure, $R_1 = r_1$, $R_2 = r_2 - r_1$ and $R_3 = r_3 - r_2$. r_1, r_2 and r_3 are now found from the three expressions—

$$r_1 = \frac{(r_3 + R_m)I_m}{I_1}$$

$$r_2 = \frac{(r_3 + R_m)I_m}{I_2}$$

$$r_3 = \frac{V_m}{I_3 - I_m}$$

The terminal resistances differ from the individual shunt resistances and are :—

Range 1, $\dfrac{R_1(R_2 + R_3 + R_m)}{r_3 + R_m}$

Range 2, $\dfrac{r_2(R_3 + R_m)}{r_2 + R_3 + R_m}$

Range 3, $\dfrac{r_3 \times R_m}{r_3 + R_m}$

The relation between the ranges may be anything required, but in practice it is better to limit the ranges to common factors, such as multiples of 10, for ease of scale reading, or factors of 2 and 5.

E. H. W. B.

"**Radiolocation**" is the title of a booklet issued by the Marconi International Marine Communication Co. to assist navigators in assessing and interpreting radar responses. The major part of the 16-page booklet is devoted to notes on target recognition and explains possible misinterpretations due to land contours, vegetation and beam and pulse distortion. The booklet is obtainable from the Technical Information and Publicity Division, M.I.M.C. Co., Marconi House, Chelmsford, Essex, price 2s 6d.

FURTHER NOTES ON THE

Wireless World Television Receiver

WITH the opening of the Holme Moss television station some changes are needed to the signal- and oscillator-frequency circuits of the *Wireless World* Television Receiver in order to permit its reception. Of the two receiver units described—the straight t.r.f. and the superheterodyne—only the latter is suitable for stations other than London. The reason is, of course, that only the superheterodyne was designed for vestigial-sideband reception.

This superheterodyne was described in *Wireless World* for February and March 1949, and the modifications needed for Sutton Coldfield appeared in August 1949. These modifications comprised mainly a change in the number of turns on the two signal-frequency coils and the oscillator coil. In addition, however, the r.f. intervalve coupling was altered from the double-wound transformer used for London to a single-winding because the former was found unsuitable at the higher frequency of Birmingham. This single-wound coupling is now retained for all new channels.

The circuit diagram of the signal circuits thus still takes the form given in Fig. 1 of the article in the August 1949 issue. The coil windings for the different channels are given in Table 1, in which the previously published details for London and Birmingham are repeated for ready reference.

The formers used are, of course, the same as in the original design and are prepared from ¾-in paxolin tube. In the case of the oscillator coil polystyrene tube is preferred but this is difficult to obtain and paxolin is a satisfactory alternative. The winding lengths are specified in Table I as well as the turns since the inductance depends on both. No. 36 d.s.c. wire is used for the signal-frequency coils and No. 20 enamelled for the oscillator; in all cases the oscillator coils are close wound.

The aerial coil has for each channel 1½ turns of No. 36 interwound at the earthy end for the aerial coupling and the entry 9 + 9 turns for the London intervalve coil signifies that this is a double-wound transformer, as previously described.

There is one possibility of difficulty arising in the case of Channel 2, Holme Moss, and this is through i.f. harmonic feedback. The usual method of avoiding this is to pick the intermediate frequency so that it does not occur.

It is not possible to find any frequency which avoids the possibility of the effect on all television channels unless the frequency is unusually high. In this receiver the frequency was chosen to avoid the effect on as many channels as possible with a moderately low frequency and the precaution was taken of including very thorough screening in order to prevent the feedback at its source. As a result there should be no trouble; in fact, no trace of it has been evident in tests with a signal generator.

However, if the screening is less perfect than in the original model, or any defects of construction are present which permit feedback to occur, then an interference pattern of diagonal bars may appear on the screen on Channel 2. If such a pattern is found the proper course is to remove the coupling between the input and output circuits which is responsible for it. An alternative is to increase the intermediate frequency by 1 Mc/s. To do this all i.f. coils, both sound and vision, should have 7.5% less turns and all i.f. alignment frequencies should be increased by 1 Mc/s.

Apart altogether from changes for new television channels, experience with the set has indicated a few minor alterations which generally improve the performance and which can, with advantage, be made by any user of the set no matter what station he receives.

It has been found desirable to add a linearity control to the frame time base. Originally, the curvature of the valve characteristic was relied upon to correct for the distortion introduced by the time constant of the output circuit. It has become evident in recent months that this is not completely successful. This may be because of minor changes in the valve characteristic or it may be that more people are using similar, but not identical, alternative valves.

Whatever the precise cause, there is no doubt that compensation by the valve characteristic is now failing increasingly to be sufficient. Fortunately, a very simple remedy exists, and requires the addition of only one extra resistor and capacitor. The relevant

Table I

Channel	Station	Aerial Coil			Intervalve Coil			Oscillator Coil	
		Turns	Length (mm)	Alignment Frequency (Mc/s)	Turns	Length (mm)	Alignment Frequency (Mc/s)	Turns	Frequency
1	Alexandra Palace	12	7.5	45	9+9	7.5	43	15	32
2	Holme Moss	11	7.5	51.5	8	7.5	49	10	38.75
3	—	10	10	57	7	7.5	54	9	43.75
4	Sutton Coldfield	10	13	61.5	6	10	59	8	48.75
5	—	9	13	66.5	5	7.5	64	6	53.75

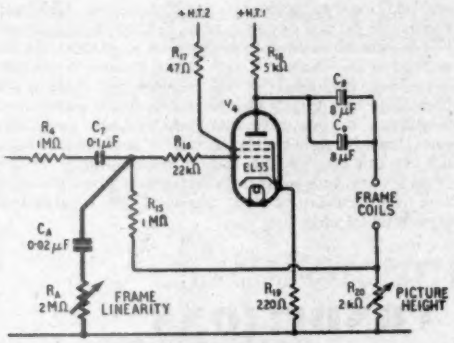


Fig. 1. Output stage of frame time base modified to include an adjustable linearity control. The new components are R_A and C_A.

portion of the frame time-base circuit is shown in Fig. 1 with the original circuit references. The linearity control comprises a 2-MΩ variable resistor R_A in series with a 0.02-μF capacitor C_A.

The adjustment of R_A has a considerable effect on picture height and so it must be carried out in conjunction with the height control R_{20}. It is preferably carried out on a transmission of Test-card C; if it is done on the ordinary test signal preceding the programme the aim should be to adjust for a perfect circle. If R_A is made too low in the course of adjustment the top of the picture will become cramped and may fold over.

Some constructors have found difficulty in obtaining good horizontal linearity, their main trouble being in preventing a vertical white line from appearing towards the left-hand side of the picture. The trouble is mainly one of adjustment, for it is not always realized that the settings of the width and linearity controls are both critical and interdependent. In addition, some constructors do not seem to be aware of the modified damping circuit which appeared in *Wireless World* for April 1949, p. 128. This circuit is usually easier to adjust than the original one.

One possible cause of difficulty lies in resistor tolerances. The chain of damping resistors R_{19}–R_{21} (Fig. 1, July 1947) comprises four 1-kΩ resistors and the variable resistor R_{22} is also of 1 kΩ, the aim being to obtain a total resistance variable from 1 kΩ to 5 kΩ. However, because of resistor tolerances it is possible for small gaps to appear in the range. To avoid this, R_{19}, R_{20} and R_{21} should each be shunted by a resistor of 4.7 kΩ, 1-W rating. This makes each step nominally 0.825 kΩ instead of 1 kΩ and the total range is from 1 kΩ to 4.475 kΩ which is adequate and provides some overlap between steps.

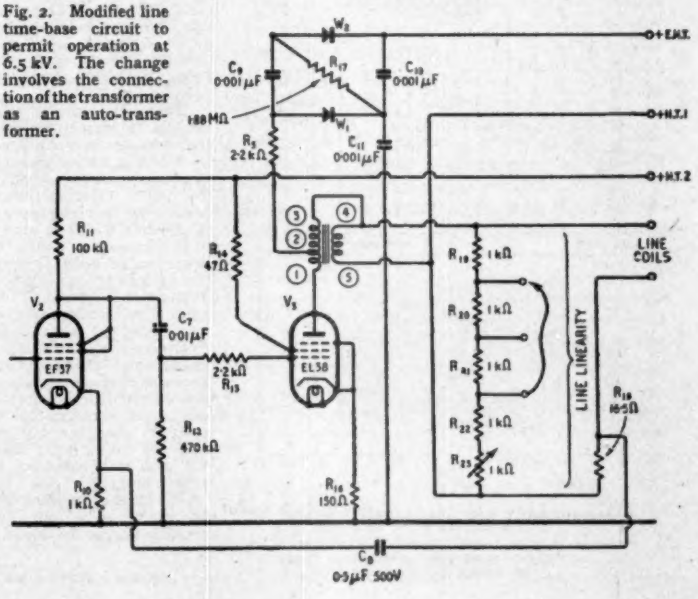
It should be pointed out that this change is desirable only if the optimum setting of the linearity control comes at one extreme end of its travel. If it comes within the range, so that one can pass through an optimum setting on R_{22}, it will not help.

A good many enquiries have been received about the use of this set with a 12-in tube. Such a tube can be used without any modification at all as long as it is of the normal type with a deflection angle of about 50°. However, the brightness obtained at the normal 5 kV existing in this set is below present-day standards. It is not possible to increase this voltage without also modifying the time base because a higher voltage requires an increase of scanning current.

However, a simple modification does permit operation at about 6.5 kV with full scan and the modified circuit is shown in Fig. 2. The change comprises essentially the connection of the output transformer as an auto-transformer so that the effective ratio becomes 5 : 1 instead of 4 : 1.

There is an increase of current in the deflector coil and due to this and to the higher ratio the e.h.t. voltage is increased to about 6.5 kV. Because of this the voltage ratings of C_9, C_{10}, C_{11}, W_1 and W_2 should be increased from 2.5 kV working to about 3.5 kV. The arrangement has actually been tried out with the original components without any trouble but their lives would almost certainly be reduced by such operation. Anyone who is using the normal arrangement and wishes to adopt the new one might well feel inclined to do so with the old components and to employ them until they fail, but anyone starting afresh should unquestionably use the proper ratings. The old parts might work for months or years under these

Fig. 2. Modified line time-base circuit to permit operation at 6.5 kV. The change involves the connection of the transformer as an auto-transformer.



over-run conditions or they might fail in a matter of days.

It is to be noted that the deflector coil and damping components are all at full h.t. potential, so it should be remembered that components which were previously at chassis potential are now 480 V above chassis. The feedback circuit has been modified because of this and now includes a 0.5-μF capacitor C_B.

The damping circuit is now virtually the modified one of April 1949, but the variable capacitor of that circuit is absent because with the higher transformer ratio the inherent circuit capacitance is more important and additional capacitance is not permissible. All adjustments are carried out exactly as in the original circuit.

This modification for operation at an increased e.h.t. voltage is put forward with some hesitation because it has been tried out on one set only and there is the possibility that through an accumulation of component tolerances in one direction the fly-back time may sometimes be rather slow, in which case the left-hand side of the picture will appear folded over. If this does occur there is little that can be done about it. The modification should, therefore, be regarded as experimental only.

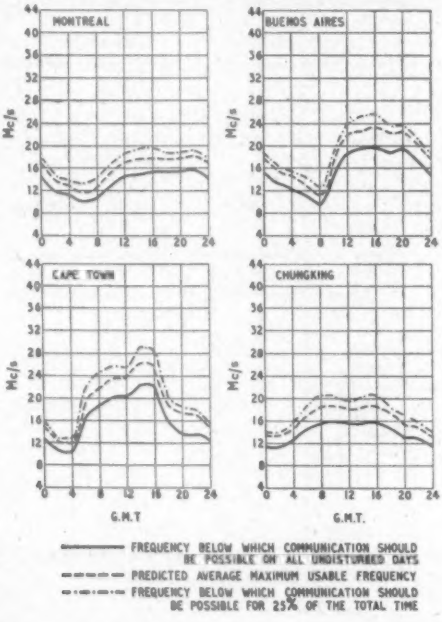
SHORT-WAVE CONDITIONS

May in Retrospect : Forecast for July

By T. W. BENNINGTON*

DURING May the average maximum usable frequencies for these latitudes decreased very slightly by day and increased considerably by night. These variations were in accordance with the normal seasonal trend, but both day and night m.u.fs were higher than had been expected, owing, it is thought, to the increased solar activity during the month.

Daytime working frequencies did not show much variation from the previous month, and were somewhat higher than had been expected. Even so, 17 Mc/s was about the most consistent frequency for east/west paths, though 21 Mc/s was sometimes usable. Frequencies above 21 Mc/s were hardly ever heard. On north/south paths 24 Mc/s was about the highest regularly usable frequency. At night 11 Mc/s was generally usable till midnight, and frequencies below 9 Mc/s were seldom really necessary.


MONTREAL
BUENOS AIRES
CAPE TOWN
CHUNGKING
Mc/s
G.M.T.
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

As was expected, the rate of incidence of Sporadic E increased considerably during May, and often this became capable of propagating the higher frequencies over medium distances. Swedish and Danish f.m. stations on frequencies around 42 Mc/s were often audible in this country.

Sunspot activity was, on the average, higher than for many months past. The giant sunspot alluded to last month again crossed the sun's central meridian, on May 15th, and, during this passage across the sun's disc, attained proportions such as placed it amongst the four largest spots ever to be observed at Greenwich.

There was considerably less ionospheric storminess in May than for some time past. Disturbances did, however, occur during the periods 1st-4th, 10th-13th, 24th, and 27th-28th. The month was notable for the number of Dellinger fade-outs which occurred. Ten of these were reported, some of them of severe intensity, the worst occurring at the following times: 8th, 1515-1545; 10th, 1000-1030; 15th, 1128-1300; 18th, 1024-1255; and 23rd, 1140-1230.

Forecast.—During July there should be very little change in either daytime or night-time m.u.fs for these latitudes, as compared with those for June.

Working frequencies for long-distance communication should therefore remain relatively low by day and high by night. Over east/west circuits the highest regularly usable daytime frequency may be of the order of 15 Mc/s, and while 17 Mc/s may often be usable, it is unlikely that frequencies above 20 Mc/s ever will. On north/south paths 21 Mc/s should be a regularly usable daytime frequency, and those up to 28 Mc/s may occasionally become so. At night 11 Mc/s should be regularly usable until after midnight over most circuits, and 9 Mc/s should remain so the night through.

During July Sporadic E capable of propagating the higher frequencies should continue to be prevalent, and medium-distance communication by way of this medium should often be possible on metre waves and sometimes on longer wavelengths. Normal communication over medium distances will be controlled for several hours daily by the E or F_1 layers, and the usable frequencies for such communication should, during those hours, be relatively high.

The curves indicate the highest frequencies likely to be usable over four long-distance circuits from this country during the month.

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* Engineering Division, B.B.C.

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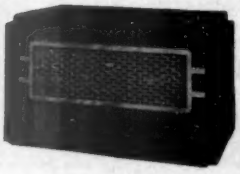

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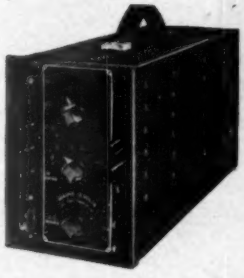

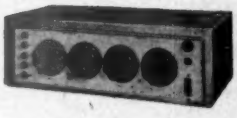

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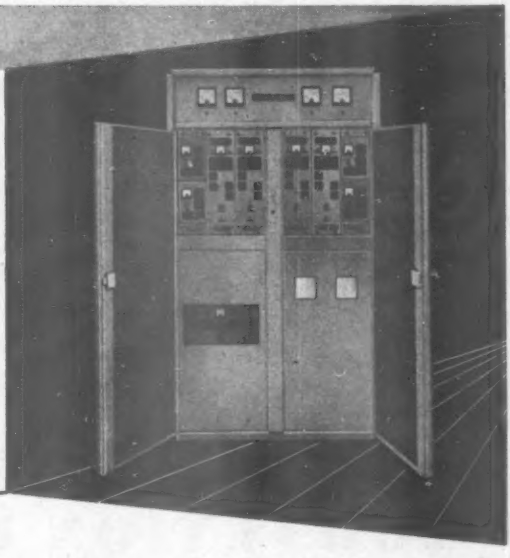

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Approach to "High Fidelity"

Signposting Some Alternative Routes—And One or Two Blind Alleys

THIS article is addressed not so much to those who have "arrived" in electro-acoustics, or to those "hi-fi enthusiasts" whom nothing will deter from the joys of the chase after the unattainable, as to the many people who have sought advice on the ways and means of obtaining quality of reproduction from records and radio which is better than that offered by the ordinary run of commercial broadcast receivers.

Ignoring for the moment decibels, frequency characteristics and all such like trees, let us step back a little and take a look at the wood as a whole.

First, a matter of terminology. According to the dictionary fidelity means "exact correspondence to the original"; qualifying adjectives such as "high" or "low" are therefore either superfluous or inappropriate. Of more practical importance is the realization that fidelity of reproduction via the medium of a loudspeaker or speakers in an ordinary living room is impossible, for the simple reason that the acoustic characteristics of the room will be added to those of the hall in which the sound originated. Even if one went to the expense of fitting up a special enclosure with sound absorbing walls, floor and ceiling, or, more simply, agreed to tolerate the use of headphones in order to exclude air vibrations in the room, it would be of little use unless a two-channel system of transmission or recording were also available virtually to transport the listener's two ears in correct relative position to a point inside the hall or studio. Even then he must keep his head still[1] and will have to forgo those subconscious minor orientations which are an essential part of attentive binaural listening.

If fidelity of reproduction is impossible there is no denying that some very pleasant sounds are frequently to be heard coming from loudspeakers of all shapes and sizes. One outstanding performance in the writer's memory was of a solo voice, heard in a small living room through the medium of an "all-dry" portable with 3½-inch loudspeaker and a run-down battery limiting the output to about 50 milliwatts! Most people have had similar experiences of being "carried away" by performances in unpromising circumstances and on analysis it is generally found that the deviations from the orginal (one cannot call them distortions in this context) are not sufficiently incongruous to destroy the illusion of reality.

How Do We Hear?

Judgment of what constitutes good reproduction is thus shifted from the objective world of measurement to the subjective, relative and often arbitrary human reaction to sound stimulus. It is often said glibly that "the ear is the final criterion," but this is only a half truth. Much is known about the mechanism of the ear itself: that the electrical potentials generated in the cochlea faithfully reproduce the acoustic waveform, but that these potentials are applied to nerve fibres which constitute individual bottle-necks to the extent that can transmit only "spikes" or pulses of their own characteristic waveform at a repetition rate with a maximum probably no higher than 4,000 or 5,000 per second. Some help in recognizing high frequencies would seem to be conferred by the fact that the region of stimulus in the cochlea is dependent on frequency, but any orderly arrangement at this point is offset by the apparently random connection and mixing of the nerve fibres connecting the cochlea to the brain. How the brain sorts out this jumble of coded signals and finally conveys the consciousness of, say, a pure sine wave of 1,000c/s at a certain loudness level is still one of those mysteries which the physiologists have yet to solve, but there seems little doubt that the faculty of interpreting this pattern is one which we acquire as the result of a long sequence of experiences beginning at birth.

Conditional Judgments

When we speak of "the ear" we generally mean the whole process of auditory perception which includes the brain and one's past history of experience and training. It is important to recognize that quality which satisfies now may prove to be intolerable in five years' time; conversely, blemishes in reproduction which are noticed at a first hearing, if they are not corrected at once, may be assimilated into the background of experience and tolerated by habit. It is well known that people who have been brought up on cheap broadcast receiver quality dislike good quality reproduction at a first hearing; conductors who spend most of their time with real orchestras dislike "canned music" of any kind.

The ear, then, is not necessarily the final criterion; it is too easily conditioned to the familiar and becomes alert only to unaccustomed elements—true or false—in the sound.[2] Direct comparison with the original—a privilege of the few in broadcasting and recording organizations—is the only firm basis for the development of a critical faculty—unless one has the nerve to take a quality headphone portable to the concert-hall!

The point of this somewhat discouraging introduction is a practical one. In the long run it pays to buy or build an amplifier a little better than one which may now be regarded as adequate. Not so long ago the valve makers accepted non-linearity equivalent to 5 per cent harmonic distortion as the basis for calculating the output available from power valves, since there seemed little point in gilding the lily by working to lower limits. Later, 2 per cent was put forward as a standard of good practice for public address installations, and the criterion for monitoring

[1] M. G. Scroggie (Letter to the Editor, "*W.W.*," April, 1951).

[2] See also, report of I.E.E. discussion meeting "To What Extent Does Distortion Matter in the Transmission of Speech and Music," *Wireless World*, March, 1948, p. 97, and report of B.S.R.A. lecture "Some Physiological Factors in Quality Appreciation," by E. A. Vetter, *Wireless World*, February, 1949, p. 52.

work in studios and high-quality domestic reproducers is now a fraction of 1 per cent. Much higher non-linearity distortions are inherent in the mechanism of the ear (it is thought that they may be an essential part of the mechanism by which we appreciate loudness), but we have lived with them so long that we can accept them and yet notice the slightest additional distortion. The effects of separate non-linearities are cumulative; the distortion products multiply like weeds and methods of control are similar—they must be cut down before they have time to seed.

Wide frequency range is of secondary importance to low non-linearity distortion, but it is generally more than adequate in any amplifier with the quality of components and degree of negative feedback necessary for keeping distortion down to fractional percentages, and one can always throw too wide a response away with tone control circuits if it proves an embarrassment, which more often than not it is! Bass response below 70c/s is seldom required for the appreciation of the musical content of the majority of orchestra works and level responses down to 20 or 30c/s often bring in hum and motor rumbles when reproducing records. At the other extreme a sustained response at high frequencies will faithfully reproduce surface and background noise and the more virulent elements of non-linearity distortion in other parts of the equipment or in the original transmissions and recordings. As P. P. Eckersley has put it: "The wider you open the window, the more the dirt blows in." Too little top response will mar the pleasure of those who have an appreciation of orchestral tone colour. On some vintage modern discs we can safely go up to 15 or even 20kc/s (while the records are brand new!), but, on the average, a cut or "roll off" at 8 or 10kc/s is more pleasant, while many worthwhile pre-war records benefit by a cut to 5 or 6kc/s. So a well designed variable top-cut control and a compensating bass control are a *sine qua non*. In restricting frequency range, it is a matter of experience that the response should be trimmed at both ends symmetrically to preserve good balance. A useful rule of thumb is that the product of the highest and lowest frequencies should equal 500,000; thus, 50-10,000c/s, 100-5,000c/s, etc.

Pickups

Choice of a gramophone pickup does not present any great difficulty and good results are obtainable with either moving-iron, moving-coil or piezoelectric crystal movements. The smaller the mass of the moving parts (which include the stylus) the less likely is there to be record wear. If the voltage-generating element is heavy some sort of compliance between needle point and armature or cartridge is essential. With the older heavy magnetic pickups a fibre needle provided the buffer element—at the cost of high-frequency loss; in one modern crystal pickup a cantilever stylus mounting is designed to present a low needle-point impedance in the mechanical equivalent of a transmission line. Moving-coil pickups have lower outputs than the moving-iron types, but are easier to design for low harmonic distortion. Single-turn ribbon pickups have potentially the lightest movements of all, but as they are also the least sensitive experience is necessary in designing the coupling and pre-amplifier circuits for low hum; the makers usually provide guidance in these matters.

Diamond is the best stylus material, but it must be properly ground and polished (an expensive process). Sapphire is a good if variable material and tungsten carbide is gaining in favour because of its toughness. All the foregoing are suitable for use only with very low mechanical impedances at the needle point. At high frequencies accelerations up to 1,000 times that due to gravity may be experienced, and, with heavy moving parts large forces are involved and damage to the groove wall is inevitable. When in doubt use fibre and accept the h.f. loss; that is unless you can afford to throw records away after a few playings.

A simple r.f. amplifier and detector circuit is best for radio reception on a quality basis, but owing to the congested state of the ether one needs to be close to a main station to avoid background interference. The alternative, until an e.h.f. broadcasting system is established, is a broad-band superhet unit with two or more degrees of selectivity.

Loudspeakers

The choice of a loudspeaker is a purely personal matter, for this reason; the perfect loudspeaker has yet to be made and, whatever you buy, some inadequacy in one form or another will have to be accepted. What that inadequacy will be depends primarily on what type of programme material you are interested in, and to some extent on any blind spots which may exist in your faculty of hearing. People whose first interest is in the spoken word, or the solo singer or instrumentalist, need not be so critical of non-linearity distortion, which will, however, be of paramount importance if orchestral or concerted music of any kind is the main objective. Conversely, smooth deviations from a level frequency response may not seriously affect orchestral reproduction, but a bass resonance may have a disastrous effect on speech, and any prominence in the frequencies around 3,000-5,000c/s will draw undue attention to sibilants.

Another point to watch for is the general level at which a good balance of tone is produced. Some loudspeakers, which sound good at levels which annoy the neighbours, give an emaciated performance at reduced volume—this quite apart from the natural apparent loss of bass and top at low levels inherent in the characteristics of the human ear.

You will be very lucky if you hit first time on a loudspeaker with which you will be still pleased after living with it for 12 months; and don't turn down an otherwise good unit because it "has no bass response." In nine cases out of ten the first judgment on a really true bass response is that it is not there at all!

There is as yet no unanimity as to which principle of diaphragm construction gives best results, though the moving-coil drive is universally accepted. Single and twin-diaphragm, direct radiators, combined low-frequency direct radiators and concentric high-frequency horns—all are capable of first-class performance when handled by skilled (or lucky) designers. Opinion is equally divided on the question of the best method of mounting. Large baffles, holes in the wall, closed and vented cabinets all have their advocates. The vented cabinet is popular because it is reasonably compact and gives an extended bass response, but its resonance must not be too "live," or coloration will be evident on music as well as speech. There is general agreement that the loading of a horn offers many advantages, particularly in the matter of transient response.* The snag with horns is that their

* Discussed in detail in another article in this issue.—Ed.

physical size determines the cut-off at low frequencies, and to reproduce adequately below 100c/s they have to be built rather larger than the average room will accommodate. A combination of horn and bass resonator of either the pipe or the Helmholtz type affords a possible solution of this difficulty.

Realistic reproduction must take into account the apparent size of the source of sound. It is just as incongruous to hear a voice coming from a battery of loudspeakers spread over an area of several square feet as to listen to an orchestra from the "point source" represented by a single directional unit. In one commercial unit scattering by reflection from the corner walls of high-frequency sounds, and the natural diffusion of very low frequencies from a bass chamber, give the illusion of depth on orchestral music, while the residual directional properties of the forward radiation from the main cone occur in a band of frequencies which predominate in speech and help to reduce the apparent size of the source. An alternative solution, which should appeal to the experimenter, is to devise a portable screen made up of deflecting surfaces which can be placed in front of the loudspeaker on appropriate occasions.

At least one specific recommendation is permissible, and it applies to all types of loudspeaker employing a moving-coil drive; get one with the highest flux density in the magnet that you can afford, since this is the very foundation of good transient response and high electro-acoustic efficiency.—F. L. D.

New American Walkie-Talkie

Sixteen Valve Self-contained Set for Mobile or Stationary Use

AN outstanding example of modern miniaturization technique is the new walkie-talkie v.h.f. radiotelephone (Type AN/PRC-10) designed and made by the Radio Corporation of America for the United States Army Signal Corps. It is intended as a replacement for the SCR300 equipment used extensively by the American forces during the recent war, and is about half the size and half the weight, though giving about twice the operating range. The design allows for operation as a portable station with the set carried like an infantryman's pack, as a mobile station in a vehicle, as a fixed ground station or as an unattended relay.

The AN/PRC-10 set is frequency modulated, contains 16 valves and some germanium diodes and is housed in two waterproof cases held together by spring clamps. The upper unit, comprising the transmitter and receiver, measures 9½in × 10½in × 3in and weighs 9 lb only. The complete equipment as a portable pack set, including transmitter-receiver, battery power unit, carrying harness, hand microtelephone unit, aerials and spare parts, weighs about 25 lb.

Reduction in size and weight compared with the SCR300 is effected by the use of sub-miniature valves in all positions except the transmitter output stage, which is a miniature; by the use of very small subassembly units and by scaling down everything proportionally. For example, the tuning coils are under ½ in in diameter yet give a "Q" of near 100; the five-gang tuning capacitor is only about half the length of the one used in the SCR300, which is not large by any standards of comparison, and the complete i.f. subassemblies measure ¾ in in diameter and 2 in long, or

New R.C.A. walkie-talkie designed for the United States Army Signal Corps. This illustration shows the equipment assembled as a pack set.

no larger than a miniature valve, and contain the whole of the stage components including the valve. They are in hermetically sealed metal cans with base pins and plug into the set. In the event of a failure of any unit due to valve or components, the whole unit is replaced by a spare, of which several are included in the equipment.

The receiver is a superhet with two r.f. stages, mixer and separate oscillator, five i.f. stages acting also as grid circuit limiters, discriminator using two germanium diodes and a single audio output stage. There is also a squelch valve for muting the set in the absence of a carrier and two crystal-controlled oscillators for checking the calibration. One on 1 Mc/s injects into the aerial coil, the other on 4.3 Mc/s into the i.f. amplifier and harmonics of the former produce

calibration pips every 1 Mc/s throughout the tuning range. The receiver sensitivity is 0.5 μV for 2.5 mW output.

An electron-coupled master oscillator, with its tuning capacitor included in the ganged capacitor unit, is used in the transmitter. Send and receive frequencies are synchronized and the transmitter frequency is controlled by comparison to the receiver's local oscillator. A small portion of the output is fed into the receiver, *via* the aerial coil, which is common to both the transmitter and the receiver, there it is amplified, passed to the discriminator and the d.c. output used as the controlling voltage for an a.f.c. (automatic frequency control) circuit. The transmitter output is about 1 watt and the frequency deviation is 15 kc/s.

Two aerials are provided, one is a seven-section whip for stationary use and when maximum range is required, the other is a semi-rigid type made of strips of steel tape riveted together. It is about 3 ft long and can be folded into a small space.

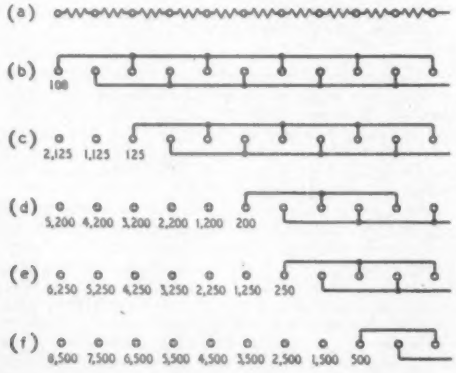
Multiple-Unit Resistors

Various Values by Series-Parallel Connections

IF a number of similar resistors are available they may obviously be used in series for values up to n times the resistance of one, if n is the total number of units. Thus if ten similar units each of 1,000 ohms are available they may be used for any resistance from 1,000 to 10,000 in steps of 1,000 ohms. The same principle holds exactly for other values, such as 100,000-ohm units adding up to one megohm. This latter case is that obtained by using a standard sub-divided megohm. It is only necessary for the accuracy to be as high as that required for the measurements in view. Resistors having a tolerance of 5 or 10% will in general be useless for such work. 1% is often satisfactory, but 0.5 or 0.2% better.

In addition to the obvious 1, 2, 3, etc. times the unit resistance other combinations are possible by paralleling some or all of the units. Paralleling may be carried out even if all the units are permanently connected in series, as in the figure, and the sub-divided megohm is one example.

Different values obtainable from a tapped 10-kΩ resistor.



At (a) is shown the maximum resistance with all in series. Diagram (b) shows the minimum resistance with all paralleled. This is one-tenth of the resistance of one unit or one-hundredth of that of the total, using ten units. In diagram (c) two of the shorting straps are removed and the new resistance is now 125 ohms; by adding one or both of the remaining series units the values of 1,125 and 2,125 ohms result. Five sections paralleled produces 200 ohms, at (d); adding the remainder allows 1,200, 2,200, 3,200, 4,200 and 5,200 ohms, as before. In diagram (e) four sections are paralleled, giving 250 ohms, and by adding the remainder the values of 1,250, 2,250, 3,250, 4,250 and 5,250 ohms are obtained. With only one pair of units paralleled (f) the resistance of 500 ohms, or half that of one unit, is obtained, with totals available of 1,500 by steps of 1,000 to a maximum of 8,500 ohms.

For ease of use the resistances available are shown in the sketch. The paralleling of 3 or 6 units has been omitted as it introduces recurring decimals, and although these may be of use on occasion they are more difficult to deal with.

These arrangements are often of use in a laboratory where no real standards are available, such as a decade resistance or a Post Office bridge. Uses include series resistance for a voltmeter to change the range temporarily; they may also be used to check or calibrate a resistance tester assembled from a voltmeter and battery, requiring only the initial resistance units of known and good accuracy.

E. H. W. B.

FESTIVAL COMPUTOR

THOSE who find computors difficult to understand should make sure of paying a visit to the Festival of Britain Exhibition at the Science Museum, Kensington, where Ferranti are demonstrating an electronic digital computor that has been specially designed to show the general principles of these machines. It is called "Nimrod" because it has been arranged to play the game of Nim with human opponents—and it generally wins. This game is basically a mathematical problem, and in solving it the machine shows the three essential characteristics of an automatic computor—it calculates, remembers, and makes decisions.

Nimrod uses voltage levels to represent numbers and is aperiodic. This makes it possible to display the "thought processes" step by step, and two explanatory diagrams are lit up as the machine progresses through the problem. As well as playing six variations of the game, it can also be arranged to play against itself—a spectacle full of poetic justice for the mere human who has just been outwitted.

Altogether 480 valves are used, all Brimar 12AT7 double triodes, but since the majority of these 960 sections are only called upon to perform two simple functions for binary calculation—conduct and non-conduct—the operating conditions are not at all critical. This makes for good reliability, exceeding that of electromechanical relays according to the makers, and at the time of going to press Nimrod has not yet experienced a single failure.

Gas Discharge Tubes

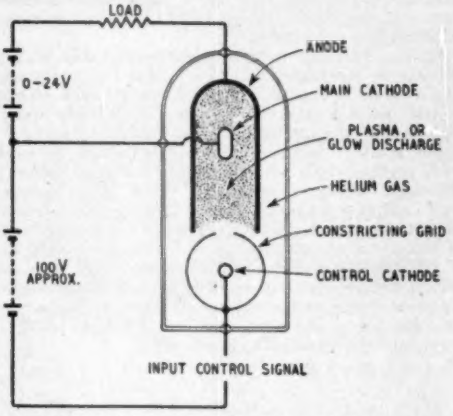
New Principles for Control, Amplification and Stabilization

THE properties of electrical discharge through gas have been known for many years now and are utilized in such familiar devices as the thyratron, the neon stabilizer and the gasfilled rectifier. There does not seem to have been much further development in this field, however, until just recently, when something like a minor revolution has been started by the sudden blossoming of some quite new ideas.

One new tube, for instance, which may have considerable repercussions on the electronics industry, is a gasfilled type in which the flow of current is directly and continuously controlled by a third electrode as in an ordinary hard triode. This represents a considerable advance on the normal gasfilled relay or thyratron where the grid merely serves to fire the discharge and has no further control over the flow of current. It also represents an advance on the ordinary hard valve which, because of the inherent space-charge limitation of anode current, has a sometimes inconveniently high impedance. Thus, combining as it does features of both the gasfilled relay and the triode, the new tube can be used not only for progressive control operations (as distinct from simple switching), but for amplification as well, especially where low-impedance circuits are desirable.

The important point about the functioning of this tube is that it does not produce a complete gas discharge between anode and cathode as in an ordinary thyratron. Instead, the extra control electrode establishes an independent glow discharge which permeates the space between the anode and cathode, neutralizes the space-charge, and serves as a conducting medium for the main flow of current. Now the density, and hence the conductivity, of this auxiliary discharge depends largely on the amount of current maintaining it, so that this current—in the control-electrode circuit—provides a direct means of controlling the main anode-cathode current. The relation between the two currents is, in fact, substantially linear, while the degree of amplification in terms of current can be of the order of 100:1. So long as the anode voltage is kept below a certain figure the control electrode continues to be effective, but above this point a complete discharge between anode and cathode takes place and the tube behaves like a straightforward thyratron.

An American version of the tube, called the "plasmatron" and described by E. O. Johnson in *Electronics* for May, 1951, has the main cathode enclosed within a U-shaped anode, at the open end of which is the control electrode—actually another cathode. Both cathodes are heated. Up to 24V can be applied between the anode and main cathode while the control cathode is kept at about 100V negative, the main current being of the order of half an amp. The I_a—E_a characteristics are very similar in form to those of a pentode and the plasmatron does, in fact, show the properties of a constant-current device. This enables it to be used, for example, as an a.f. output valve working direct into the loudspeaker speech coil, although the frequency response does fall off rather sharply at



Sketch of the "plasmatron" and external circuit. The purpose of the constricting grid round the control cathode is to increase the plasma density.

10kc/s owing to the inability of the auxiliary discharge to change its density at such a rapid rate.

A new French tube having basically similar properties is described by Raoul Besson in the May 1951 issue of *Toute la Radio*. This, however, uses a cold main cathode, while the control electrode (also cold) is described as a grid. Another important difference is that the control electrode is held at a positive potential with respect to the cathode. Physically, the anode and cathode are at either end of the tube and the control electrode is in a small appendix in the side wall—midway between them, but not interposed in their path. The anode-cathode voltage is here of the order of 300V, and, with a standing main current of 3mA and a standing control current of 2μA, a change of 1μA at the control electrode produces a change of 200μA in the main current. Again, if the normal operating conditions are exceeded a complete anode-cathode discharge takes place and the tube behaves like an ordinary thyratron. The possible applications of this tube are, of course, somewhat different from those of the "plasmatron," but the author is principally concerned with its use as an amplifier for photo-cell currents.

In this country, we understand that Mullard are working along similar lines, but no details are available yet except that the firm is chiefly interested in the cold-cathode type.

Although the gas discharge phenomenon can also be utilized for voltage stabilization, its range of application in this field has been somewhat limited because practically the only type of stabilizer to appear on the market so far has been the familiar neon tube. This, of course, is restricted to working somewhere in the region of 100 volts (per section in the case of multiple

types) with tube currents of the order of milliamps. Recently, however, a new kind of stabilizer has been introduced for working at much higher voltages with currents of only microamps required to maintain the discharge. The discharge is actually a corona formed between two coaxial electrodes in a gas filling, the anode being in most cases a single wire and the cathode a comparatively large-diameter cylinder enclosing it. When the tube is wired up with a series resistor it behaves in much the same way as a conventional neon tube and, generally speaking, gives a stabilization ratio of about one per cent.

Corona discharge tubes are now being made in this country by Nucleonic and Radiological Developments of Chelsea. A typical example from this firm uses a 10-MΩ series resistor (the tube resistance being about 100kΩ) and stabilizes at 450V with an initial current of about 10μA. Increasing the input voltage to, say, 800V produces only a 7-V rise in the stabilized voltage. Although this firm's range of tubes is at present restricted to 400-1,000 volts, the possible upper limits are actually very high and in America tubes have been produced for stabilization up to 40,000 volts. Up to 10,000V can be stabilized in a tube no larger than an ordinary receiving valve, and this order of working voltages, of course, makes the corona stabilizer very suitable for use in the e.h.t. supplies of Geiger-Muller, x-ray and television cathode-ray tubes.

R.I.C. Specifications

THREE new specifications covering the performance, requirements, production tests and schedule of types, values and sizes for capacitors have been issued by The Radio Industry Council. RIC/133 deals with ceramic dielectric fixed capacitors, RIC/134 with electrolytics and RIC/137 with metallized mica capacitors. With the exception of the electrolytics the recommended tolerances are ±2, ±5, ±10 and ±20 per cent and the capacitance values conform to the so-called "preferred" ranges for these tolerances. The ±2 per cent range of values are as for ±5 per cent.

In the case of the ceramic capacitors it is recommended that a colour code (defined in RIC/133) be used as an alternative to direct marking of capacitance, working voltage, group classification and temperature coefficient. This consists of five colours, the end one giving the temperature coefficient (+100 to −750) in parts per million per deg C, the following three the capacitance in picofarads and the fourth the tolerance.

Sections 1 and 2 covering performance requirements and production tests respectively are issued in respect of RIC/133 and 134, but section 3, schedule of types values and sizes (dimensions), etc., is included in RIC/137 as well as sections 1 and 2.

Sections 3 for RIC/112 and 113, grade 1 and 2 respectively fixed composition resistors, for RIC/132, stacked foil mica dielectric fixed capacitors, and for RIC/136, metallized paper tubular capacitors, are now available. Sections 1 and 2 were issued some time ago.

Sections 1 and 2 of RIC/133 and 134 can be obtained from The Radio Industry Council, 59, Russell Square, London, W.C.1, at 5s each. Specification RIC/137 complete with all three sections costs 7s. No charge will be made for section 3 in the case of previously purchased specifications RIC/112, 113 and 132, but for additional sections a charge of 1s 6d is made for RIC/112 and 2s for each for the other two. The complete specification RIC/136 now costs 6s 6d. All prices include postage.

There is an R.I.C. specification available now dealing with colour coding for connections in radio and electronic equipment, other than domestic radios. It is RIC/1000/C, was issued in April last, and costs 1s 6d by post.

NEW BOOK

A.C./D.C. Test Meters. By W. H. Cazaly and Thomas Roddam. Pp. 180+viii with 112 illustrations. Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 18s.

THIS book deals only with moving-coil indicating instruments and their use with resistances, metal rectifiers and transformers for a.c. and d.c. voltage and current measurement. As a corollary, ohmmeter methods of resistance and capacitance measurement are covered.

In the first chapter the basic meter movement is described. In the second, the use of shunts for extending current ranges and their calculation are treated, as well as voltmeter ranges and the ohmmeter. The 36 pages of this chapter cover all the d.c. applications and nearly two-thirds of them are devoted to the ohmmeter.

A chapter on metal rectifiers follows and there is then one on "A.C. Voltage Ranges." Current transformers are quite well treated and their use for extending both current and voltage ranges is dealt with. There is a chapter on accuracy and another dealing with the construction of a multi-range test instrument.

The book concludes with a chapter on Power and Capacitance Ranges and there is an Appendix in which the latter are analysed.

The treatment is straightforward and fairly elementary, and practical aspects are kept well to the fore. Generally speaking, the book will prove of great utility to those interested in test instruments and it is one which can confidently be recommended to them.

Few errors were noticed, but there are some. On p. 51 it is stated:—"Commercial rectifiers are normally marked by colours to show polarity; a red spot indicates which end of the rectifier would be connected to the positive pole of a source for current to pass easily. . . ." This is incorrect; in British practice the red spot or plus sign indicates the end which delivers current in a rectifier circuit; it is the end which is equivalent to the cathode of a diode valve. Some years ago germanium rectifiers were marked in accordance with American practice and in agreement with the statement in this book, but they have now been brought into line with the normal convention for copper-oxide and selenium rectifiers.

Another minor error is on p. 9, where an exaggerated example is given to illustrate the effect of meter resistance on current. It is unfortunate that the authors should have chosen the measurement of filament current of valves as their example because anyone performing the experiment will not obtain the result which they give. They have overlooked the fact that the resistance of a valve filament changes greatly with its temperature and, hence, with the current flowing. Had they chosen a simple resistor for their example all would have been well.

These are but minor points in a good little book and they detract very little from its value. W. T. C.

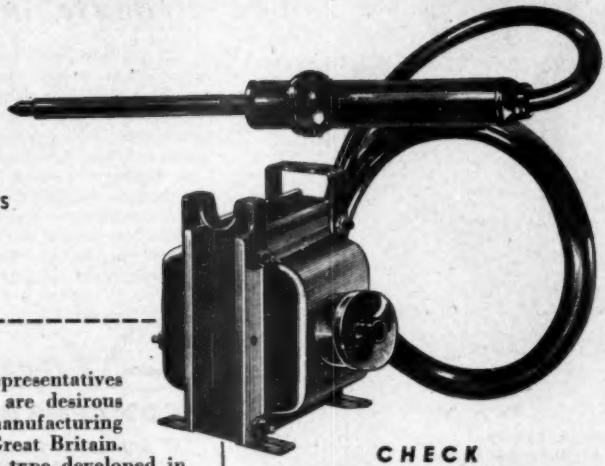
AGENTS AND LICENSEES IN GREAT BRITAIN

invited for . . .

SCOPE

(Patent Applied for)

THE SOLDERING IRON THAT HEATS FOR CONTINUOUS USE IN 6 SECONDS



The Australian and Overseas representatives for the Scope Soldering Iron are desirous of appointing agents or manufacturing licensees for this product in Great Britain. The Scope is an entirely new type developed in Australia. This design enables a very desirable combination of light weight, small dimensions and exceptionally rapid heating up time. The iron weighs 3½ oz., is only 10 in. long and heats up ready for use in six seconds. It operates from 2.5 to 6.3 volts A.C. or D.C. or from 200 to 250 volts A.C. with a suitable transformer. In short this means the Scope Soldering Iron may be used from either a battery, A.C. mains or from any reticulating system. To operate, the switch ring is pushed forward with a light thumb pressure and in six seconds the carbon element heats up the working tip to operating temperature. The switch ring is then released and the iron used in the same way as any other soldering iron. This saves considerable time and money. The iron is always ready for instant use. There is no frequent cleaning and tinning of the bit and the iron consumes no current when not in actual use. It is fully guaranteed and every part is easily replaced. The iron has been sold in Australia extensively to factories, public utilities, laboratories and private users. In instrument laboratories it has been found extremely useful because work may be assembled and the iron soldering tip applied to the required point cold without damaging other delicate wiring, and then the necessary heat developed at the soldering tip within six seconds with only a light thumb pressure on the switch ring. The price overseas should be quite competitive in view of the many added advantages obtainable from this type of iron. All enquiries should be addressed as shown below.

CHECK THESE FEATURES!

- *Operates from 2.5/6.3 volts A.C. or D.C. or from mains with transformer.*
- *Heats up from cold to ready-for-continuous use in only 6 seconds.*
- *Has an efficiency equal to that of irons rated up to 150 watts.*
- *Weighs only 3½ ounces and is 10 inches long.*
- *Can be used in conjunction with a transformer from A.C. mains or from any suitable car battery.*
- *Has low operating cost—no current is consumed when not in use; no frequent cleaning and tinning of the bit.*
- *Extremely suitable for heavy or delicate soldering—heat is applied only where and when it is required.*
- *Simple to operate—merely press switch ring forward and the iron is hot in 6 seconds.*
- *Maintenance is simple—elements and replacement tips are fitted easily and without delay. Replacements are screwed in and cost only a few pence.*
- *Fully guaranteed for three months from date of purchase. A maintenance service is available at all times.*

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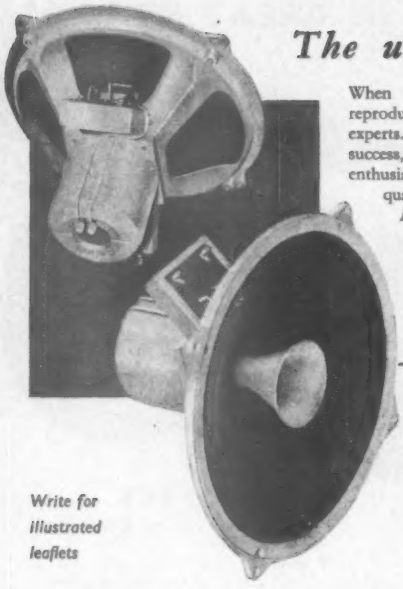

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Temperature Fuses

Operated by Heat Generated in Mains Transformers

THE idea of using a fuse in a radio, or television, receiver, which operated if the temperature of a given item exceeded a pre-determined figure, was discussed at length by F. C. Connelly in the article "Safety Precautions" which appeared in the January issue of *Wireless World*. While the risk of fire due to a breakdown in insulation, or the failure of a component, is admittedly slight, if simple and effective means can be taken to lessen the hazard it deserves all the encouragement it can be given.

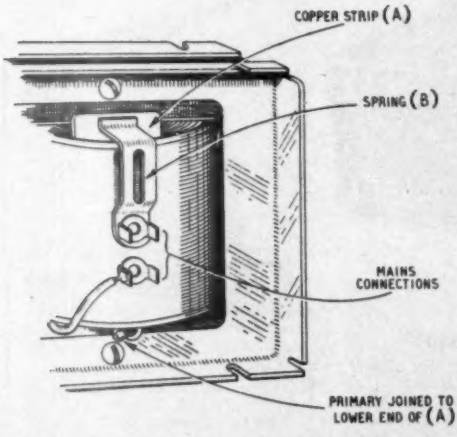
One method of fitting a temperature fuse was illustrated; another was described in a recent issue of *Murphy News*. From an article by L. Driscoll it appears that a fuse of this kind has been fitted to certain Murphy receivers for some time past.

The temperature fuse used in these sets is embodied in the mains transformer and consists of a well-insulated copper strip, (A) in the accompanying sketch, inserted between the heater and h.t. windings. This strip projects beyond the coil at both ends, at one end it is fashioned into a small lug to which is secured one end of the primary winding. The other is "soldered" by means of a special low-temperature fusible alloy, to a spring (B). The other end of this spring forms one connection for the mains supply.

If the temperature in the transformer rises abnormally, heat is conducted along the copper strip to the fusible alloy, which melts and allows the spring (B) to part company with (A) and so breaks the primary circuit of the mains transformer.

The fusible metal consists of bismuth, tin and lead proportioned to produce an alloy having a sharply defined melting temperature without an undesirable plastic range. A circuit breaker of this kind is proof against short-period surges, such as may occur at switching on. In the case of this Murphy fuse its position and composition are arranged so that the temperature rise at the hottest part of the transformer will not exceed 135 deg C when measured two minutes after the fuse has melted. It thus complies with a draft specification, British Standards B.S.415, which lays down certain safety requirements for *inter alia*, mains-operated radio apparatus. It is stated that, on test, the fuse opened 1¾ min after the inner portion of the transformer h.t. secondary winding had been deliberately short-circuited.

A feature of this type of fuse is, of course, that it can be rejointed after being blown—simply by applying heat.



Details of the temperature fuse incorporated in the mains transformer fitted to certain Murphy radio sets.

Research YOU Pay For

ALL commercial firms will tell you that research has to be paid for—some even that it should pay for itself—and although this may be considered a deplorably mundane attitude, it is quite understandable in organizations whose main purpose is, after all, to make money. With Government research we have a different state of affairs. Here is work which does not have to show immediate returns but can be directed towards the general advancement of science and industry—and however useless it may seem at the time, it does bring rewards in the end. But even this has to be paid for—and, of course, the honour falls upon us, the reluctant taxpayers.

Exactly how is our money spent? In the radio field some idea can be gathered from the annual reports of the Radio Research Board which, under the Department of Scientific and Industrial Research, is responsible for work done at various establishments, chief among them being its own station at Slough. The 1949 Report, for example (now available from H.M.S.O. at 1s 9d or 1s 11d by post), shows that the year's research was mainly devoted to propagation, including the study of ground waves, the troposphere and the ionosphere. Other aspects reviewed are the effect of weather and the forecasting of ionospheric conditions. In addition, there is information on radio noise, materials of special interest, measuring techniques at v.h.f., and on the generation of centimetre and millimetre waves.

Recently we had an opportunity to see some more recent work when the N.P.L. held its 1951 Open Days at Teddington. Amongst the new exhibits were a microwave interferometer that can be used either for determining the velocity of radio waves or for measuring distances of several metres, and the pilot model of the N.P.L. electronic digital computor with some associated apparatus. Not so new, but still interesting, were an experimental system for finding the distances of thunderstorms by analysing the received waveforms of the lightning flashes, and a demonstration of the overtone resonances of coils at frequencies higher than that of the normal self resonance. Electronic devices figured prominently as means to ends in many of the other research exhibits.

Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

Coated Screen for Cabinets

AN interesting method of screening television receivers to prevent them from radiating interference is to paint a conducting coating on the inside of the cabinet. A graphite material known as "dag" Dispersion 479 has recently been introduced for this purpose by Acheson Colloids Ltd., of 18 Pall Mall, London, S.W.1, who tell us that tests show that radiation from the e.h.t. and line time-base generator is attenuated by 20-30 db, a typical case being a reduction in measured field strength from 200μV/m at 21ft to 31.5μV/m at 9ft with a 210-kc/s signal. The efficiency of the screening is comparable at 120 kc/s with that of copper mesh having 36 strands to the inch, and although the coating is not so good at higher frequencies it is still of the order of 60 per cent efficient at 210kc/s

Miniature Hearing Aid

A HIGH degree of amplification without distortion is claimed for the new K30 miniature hearing aid by Amplivox, of 2 Bentinck Street, London, W.1. It has a flat-response microphone and is used in conjunction with the Amplivox E3 miniature magnetic earphone, which is claimed to have a frequency response remarkably free from peaks and resonances. The maximum gain is 57db, but this can be increased by a further 7db by using another type of earphone. Plug-in valves are used for easy replacement and the chassis is housed in an aluminium-alloy case finished in either coral pink or silver grey lacquer. The batteries can be easily removed from a compartment fitted with a hinged spring cover; they are Ever Ready types, B.123 (30V) for the h.t. and D.12 (1.5V) for the l.t.

Miniature Ball Race

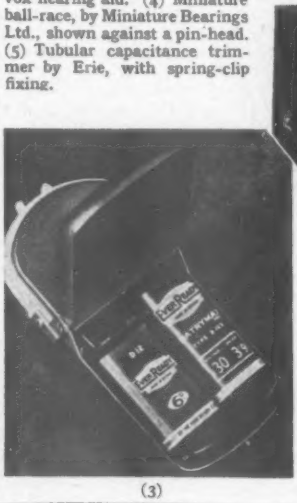
INSTRUMENT makers will be interested in the recent importation from Switzerland of a miniature ball race measuring only 1.5mm (diameter) × 0.93mm. This is the type C1.5, available from Miniature Bearings Ltd., 192 Sloane Street, London, S.W.1, who act as sole British distributors for Roulements à Billes Miniatures of Bienne, Switzerland. Designed as a pivot bearing, it consists of a pressed steel cup, a dust cover, a ball cage and three chrome steel balls. The manufacturing tolerances, 1.2 and 1.6 thousandths of an inch for the depth and diameter respectively, are fairly large because pressed steel races of this type suffer slight distortion during heat treatment. A heavier grade of the C1.5 is available with an overall diameter of 1.65mm.

Television Pattern Generator

FOR checking and adjusting television receivers in the absence of a transmission, a synchronized test-pattern generator has been produced by Radar Radio & Television, Ltd., of 26 Oakleigh Road, New Southgate, London, N.11. It comprises a signal generator for feeding simultaneous sound and vision signals into the aerial socket of a receiver, with provision for switching off the sound signal when required. A video waveform with sync. is also available for injection into the video stage. The pattern modulating the vision signal (approx. 10mV output) consists of a number of vertical bars divided into horizontal sections, each section being graded from black (30 per cent modulation) to full white (100 per cent modulation). Provision is made for removing the pattern modulation and leaving a blank unsynchronized raster, and for unlocking the frame synchronizing frequency from the mains so that hum can be seen.

The generator is a portable instru-

(1) Television pattern generator, by Radar Radio & Television. (2) Pre-heated soldering iron by Grafton, Kersten & Co. (3) Amplivox hearing aid. (4) Miniature ball-race, by Miniature Bearings Ltd., shown against a pin-head. (5) Tubular capacitance trimmer by Erie, with spring-clip fixing.



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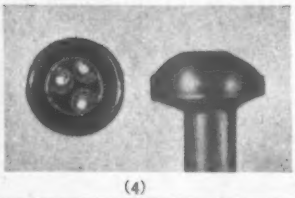

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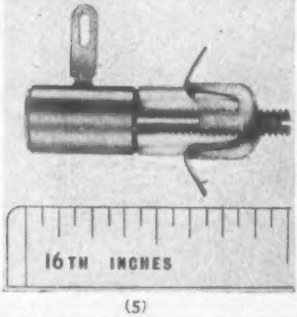


(5)

ment, weighing 15½lb, for use on a.c. mains. Two versions are available, Model L for the London vision and sound frequencies, and Model B for the Sutton Coldfield frequencies.

C.R. Tubes for Television

Two new 12-inch television c.r. tubes with aluminized screens have been announced by the General Electric Company. Type 6705A has a 6.3-V heater and type 6706A has a 10.8-V heater; both have white screens and can be used at e.h.t. voltages up to 10kv.

New Trimmers

THREE new trimming capacitors have recently been announced by Erie Resistor, Ltd., of Millora Works, Beevor Road, South Denes, Great Yarmouth. Type 531 is a compact tubular trimmer designed for low minimum capacitance and a high maximum-to-minimum ratio, the ranges available being 0.5-5pF and 1-8pF. To vary the capacitance an adjusting screw moves a plunger up and down inside the dielectric tube, and in the 1-8pF range this takes 18 complete turns to go from minimum to maximum.

Silvered ceramic is used for the rotor and stator in the type 557, which is available at the moment with a negative temperature co-efficient of 750 parts/million/°C in the ranges 5-30pF and 8-50pF. It has a slot for screwdriver adjustment in the ¼-in diameter rotor. Finally, the type 135 is claimed to be the first trimmer produced in this country that is fully sealed (effective against vacuum and a pressure of two atmospheres) and fully tropicalized (temperature range −50°C to +100°C). It is available in two ranges: 1-12pF (with positive temp. coeff.) and 3-50pF (with neg. temp. coeff). The depth and diameter are both approximately ¼in and adjustment is made by screwdriver.

Pre-Heated Soldering Iron

ONE disadvantage of the small pencil-bit type of iron used in fine soldering work is that the bit tends to get too hot for the solder and to burn away rapidly when not in use. This is obviated in the new "Neoflec" soldering iron, produced by Grafton, Kersten & Co., Ltd., which is kept just below the melting point of solder when not in use, but can be brought up to the required soldering temperature almost instantaneously by pressing a button on the handle. The 24-volt element is inside the nickel-plated bit so that the transfer of heat to the work is very rapid, and in this way a very fine bit is made possible because there is no necessity for an accumulation of heat.

A transformer giving 2 amps at 24V is required to operate the iron, although it will also work at 25-26V and can be run from a battery; the consumption is 19W in the pre-heat condition and 43W at full heat.

At the moment, the iron can only be supplied to manufacturers, radio servicing technicians and for export. The address of the firm is 77 South Audley Street, London, W.1.

MANUFACTURERS' LITERATURE

Dry Battery Manufacture described and illustrated in a well-produced booklet marking the fiftieth year of The Ever Ready Company (Great Britain) Ltd., of Hercules Place, Holloway, London, N.7.

Mobile Radiotelephone: specification and description of the "Reporter" in a leaflet from Pye Telecommunications Ltd., Newmarket Road, Cambridge.

Export Catalogue of Ediswan valves from the Edison Swan Electric Co. Ltd., 155 Charing Cross Road, London, W.C.2.

Steel C.R. Tube, type T901, described in a leaflet from The English Electric Co. Ltd., Queens House, Kingsway, London, W.C.2.

Quartz Crystal Units (G.E.C.) catalogued in a booklet from Salford Electrical Instruments Ltd., Peel Works, Silk Street, Salford, 3.

Miniature Standard Cell (Weston); specification in a bulletin from Muirhead & Co., Ltd., Beckenham, Kent.

Central Aerial Systems for flats (radio and television) described in a booklet from E.M.I. Sales & Service Ltd., Wadsworth Road, Greenford, Middlesex.

Pocket Valve Data book containing abridged data from Mullard Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

Television Feeder Cables catalogued in a folder from W. T. Henley's Telegraph Works Co. Ltd., 95 Aldwych, London, W.C.2.

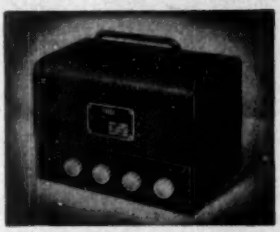
Components Catalogue (1951) from M. Watts & Co., 8 Baker Street, Weybridge, Surrey.

Switch Catalogue from Arcolectric (Switches) Ltd., Central Avenue, West Molesey, Surrey.

Wave Analyser (tunable filter type) described in a bulletin from Muirhead & Co., Ltd., Beckenham, Kent.

Enclosed Racks and parts catalogued in a leaflet from Alfred Imhof Ltd., 112-116 New Oxford Street, London, W.C.1.

TRIX
Quality
SOUND EQUIPMENT



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Separate input sockets are fitted for gramophone pick-up, microphone and radio inputs, with appropriate selector switch on the front panel.
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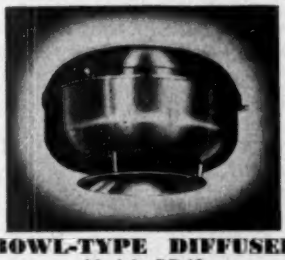

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Specially suitable for multi-speaker systems over wide areas. Equally suitable for speech and music. Incorporates a high-quality 10" unit with power-handling capacity of 5 watts (approx.). Rubber sealed cable entry.

Full details of these and other models in the large Trix range of Sound Equipment available on request. Send for latest catalogue and price lists.

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RANDOM RADIATIONS

By "DIALLIST"

Good Show

BY THE TIME that you read this the Joint Engineering Conference will have taken place. It was a splendid plan and both those who first thought of it and those who did the vast amount of hard work involved in organizing it and carrying it out deserve warm thanks and congratulations. The idea of the whole thing was this. The branches of engineering covered by the three senior institutions—the I.C.E., the I.Mech.E. and the I.E.E.—are becoming more and more closely inter-connected: you can't build a railway without civil engineers to lay the track, make the tunnels and build the bridges; mechanical engineers to design the rolling stock and other machinery; and electrical engineers to see to power supplies, signal systems and so forth. Each branch makes its own contribution to shipping, telecommunications, broadcasting . . . the list is endless. And the work of each branch must dovetail in with the others. Very well then; what could be more useful than a joint conference of the three institutions, arranged specially to bring home to engineers of any of these kinds how their work must fit in with that of the other two branches, and that of each of those branches with theirs? It was an excellent idea to devote the mornings to papers and discussions and the afternoons to visits to factories and so on, providing first-rate practical examples of the co-ordination of these three sorts of engineering.

The Unattended Radio Transmitter

AM I RIGHT in believing that this country pioneered the development of the unattended radio transmitting station and, in particular, that used as a broadcast relay? I think so; but doubtless readers will correct me if I'm not. Whether or not we were first in the field, we have gone right ahead in the practical application of the idea, for no other country can point to anything approaching the Third Programme transmitter at Daventry—to say nothing of the numerous smaller stations which go on quite happily relaying this programme or that, working all on their own and with no human attention save what comes into the category of routine maintenance. Two basic inventions, both British to the best of my knowledge, are responsible for making the unattended wireless transmitter something more than a beautiful dream. The first of these concerns the operation of two or more transmitters in parallel at one site: a station could not work unattended satisfactorily if a fault, such as the "blowing up" of a valve, would put it completely out of action; with two or more transmitters running in parallel such a technical hitch (to use the B.B.C.'s official term) means to the listener that the signal is still there, though its strength is reduced for the time being. The second important invention is automatic monitoring, which enables a relay transmitter to call attention to its own shortcomings.

Supplying the World

Whether or not we originated the idea, we seem to be recognized now by the rest of the world as *the* producers of reliable unattended transmitting apparatus. The Marconi Company, for instance, are now engaged in making no fewer than seventeen of these equipments, ten for Italy and seven for Sweden. As both of these countries have long been amongst the most progressive in the matter of developments in wireless, this is indeed a compliment to our radio industry. In these transmitters the parallel principle is given the fullest play; each, in fact, consists either of three 660-watt or four 500-watt units working in phase to provide a 2-kilowatt output. Should a fault occur in any unit, the transmitter automatically switches itself off. Within from two to five seconds the faulty unit is isolated and cut out—still automatically—and the others are switched on again. A fault thus means a barely noticeable interruption of the service, followed by a comparatively small temporary falling-off in signal strength.

Wave-Change Switches

THOUGH THE BROADCAST RECEIVING SET is now approaching its thirtieth year as a piece of domestic equipment, some of its original weak points still remain. Two in particular come to mind: the volume control and the wave-change switch. The commonest types of these both contain sliding contacts and these are a frequent source of bother, particularly in the switches. Surfaces corrode in time; fine dust finds its way on to them and, absorbing moisture from the air, forms a thin cement-like coating. The set becomes more and more noisy and something has to be done about it. One effective way of cleaning up dirty contacts is to make use of that very fine abrasive paper—far finer than the finest grade of emery cloth—the technical name of which I can't for the life of me recall, though I've no doubt some kind reader will step into the breach. I still have a little left from a supply I bought long ago. Cut a narrow strip of this paper and fold it lengthwise so that there is an abrasive surface on both sides. Manœuvre it into each contact of the switch in turn, working the knob to and fro as you do so. You must not leave the contacts dry for, as an article in *W.W.* some time ago showed, they'll wear very quickly if you do. A good lubricant can be made by mixing two drops of mineral oil into a teaspoonful of lighter fluid. Apply a minute amount with a small *clean* feather. The lighter fluid evaporates and leaves a thin lubricant film.

Sets and Shocks

That the wireless set is one of the safest of all articles of domestic electric equipment is shown by the very small number of accidents for which it is responsible, despite its daily use by millions of folk who know nothing whatever about electricity. The same goes for television sets. The recent fatal accident to a bo., due to a faulty televisor, was given a good deal of publicity in the lay press as the "first television fatality." As a matter of fact, it was the "sound" portion of the receiver which was concerned and not the purely vision part at all. This sad business was caused by a chance defect that might equally well have arisen in a "universal" sound-broadcast set.

Interference Problems

THE WORK DONE by the I.E.E. Committee on Radio Interference and that still in progress covers a multiplicity of the wireless reception problems of to-day. It has, for instance, already prepared jointly with the B.S.I. codes of practice for the abatement of interference from motor ignition systems (CP1001) and from medical and industrial h.f. apparatus (CP1002). Others dealing with

fluorescent lamps and with interference suppression in general are on their way. The advice of the I.E.E. Committee is always available to the P.M.G.'s Advisory Committee on Interference—if they ask for it. One only hopes that they do!

Does Quality Matter?

WHEN I READ or listen to dissertations on the quality of wireless transmissions I often find myself wondering whether the matter is of any importance at all to the big majority of listeners. I do not mean that they don't appreciate high-fidelity reproduction when they hear it; what I am suggesting is that they do not hanker after good quality if it does not come their way. A wild statement? There's no proof that any such thing occurs? I accept the challenge. Have you ever heard anyone complain that the sound accompanying the television transmissions from Sutton Coldfield is inferior in quality to that radiated from the Alexandra Palace? No? Nor me neether, as they say in Yorkshire. Yet here are the cold, hard facts. A.P. deals faithfully with a band of audio frequencies extending up to about 12,000 c/s; the sound from Sutton Coldfield is "piped" from London over a telephone pair and has a cut-off at 5,000 cycles or even a bit lower.

Is the Pentode Responsible?

Wondrous as are the benefits which the pentode valve has conferred on us in other parts of the receiving set, I am not at all sure that the output pentode, so widely used nowadays, is not responsible to a very large extent for the general acceptance of not-so-high-fidelity reproduction. You can "tame" the output pentode to some extent by using "corrector circuits" and heavy negative feedback; but by doing so you don't entirely kill its propensity to introduce one of the most distressing forms of distortion, that concerned with the odd-numbered harmonics. The pentode tends to accentuate the amplification of the upper audio frequencies. Hence, having introduced odd-numbered harmonics, it then proceeds to bring them out strongly. The average listener makes the reproduction "easy on the ears" by applying still more correction (!) by way of the tone control. Thereby he obtains what he terms mellowness—which means a sharpish cut off at 4,000 c/s or less. Not much use giving him—or his set—high-fidelity transmissions!

SIGNAL-LAMPS

LOW VOLTAGE · MAINS & NEON TYPES

List No. D.370. Low-voltage M.E.S. bulb acceptance, also available with M.B.C. (M.C.C.) fitting. All metal parts highly plated. Fixing to panels of 18 S.W.G.—$\frac{1}{2}$".

List No. D.350. M.E.S. Low-voltage. Fitted with front bush in Black thermo-setting "Bakelite." Fixing: On p.c.d. $1\frac{1}{8}$" 3×6 B.A. at 120°.

List No. D.180. Fitted with metal bush and bezel. Takes M.E.S., cap bulbs, but is also available in M.B.C. (M.C.C.). Fixing hole ⌀ = $\frac{1}{2}$".

List No. D.54. Mains-voltage, designed to take S.E.S., cap bulbs. This model is available with either black "Bakelite" or Nickel-plated bezel. (Nickel-plated: List No. D.54/M.)

List No. D.620. Telephone type. This fitting takes "telephone jack-lamps," also known as "No. 2" lamps, of 2-50 v. Fixing hole ⌀ :- 43/64", in panels up to 9/32" thick.

List No. D.270. M.E.S. or M.B.C. (M.C.C.) lamp acceptance. Easy bulb access is the salient feature on this model. Fixing hole :- $\frac{1}{2}$" ⌀. Max. balloon ⌀ of bulb = 12 m.m.

List No. D.109. Metal body and black moulded bezel. Fixing hole ⌀ = $\frac{1}{2}$". Bulb access front and rear. Silver-plated solder-tags ensure firm trouble-free soldering.

List No. D.200. Moulded in black thermo-setting "Bakelite." As in all BULGIN signal-lamps, a wide choice of "lens" is available, Translucent and Transparent.

List No. D.58. A similar model to List No. D.54, but with shorter body. N.B. Many of these models take Neon lamps. Send for details (185 W.W.).

A SMALL SELECTION FROM OUR LARGE RANGE

MANUFACTURERS OF RADIO & ELECTRICAL COMPONENTS

BULGIN Components

A.F. BULGIN & CO. LTD
BYE-PASS ROAD BARKING
TELEPHONE

UNBIASED | By FREE GRID

New Worlds to Conquer

I HAVE heard it stated on the authority of one of its high priests that the Automatic Computing Engine (ACE)—popularly mis-called the electronic brain—is capable of solving any problem that has a numerical answer, but I take leave to doubt the strict accuracy of this statement. For instance, can the ACE give the correct numerical answer to a man who has stood in the dock all day listening to the evidence piling up against him and wondering how many months or years the Court would award him? This is literally and metaphorically a nightmare question now that so many judges have developed the exasperating habit of postponing sentence until the day following the jury's verdict. As I can personally testify, many a hapless wretch owes a duodenal ulcer to this regrettable judicial habit.

One cannot help seeing, however, an enormous future for the ACE in the world of business as well as that of applied science. Already, I am told, chartered accountants, whose job in life it is to tell hard-faced capitalists whether they are living on their own losses or on other people's, are toying with the idea of so robotising their client's offices that floods of pent-up man-power will be released for more vital work, such as filling up football coupons, which will, of course, be checked by another type of ACE specially designed for the Pool promoters.

Surely, too, there is another type of potential ACE customer in the man who is not so much a chartered, as a martyred accountant should he make a slight slip in his calculations whereby he finds himself with insufficient cash to meet his immediate commitments. I refer, of course, to the racecourse bookmaker who, with his faithful clerk, stands in all weathers on a windswept heath shouting the odds. These men have to calculate with split-second, if not with microsecond speed and accuracy to keep their books balanced, and should they fail in this they have to calculate with still greater speed and accuracy the most favourable moment to start running, and, believe me, they have to possess considerable physical as well as mental speed.

Exasperating judicial habit.

I am aware that an ACE costs many thousands of pounds, but money is no object to these men. Only recently I noticed one of them with a hired helicopter hovering over him like Elijah's chariot of fire, and dangling grappling hooks ready to pluck him and his clerk to the safety of the skies in case of dire need.

Suppressio Veri

WE British must seem extremely dull dogs in American eyes, as according to their textbooks and "noosepapers" we never seem to have given the world a single new idea in science. Radar, for instance, we rightly regard as being peculiarly British in origin but little or no credit is given to us for it on the other side of the Atlantic, even in textbooks written by people who ought to know better.

As for the American man-in-the-street, his ignorance is so profound that when talking with one about radar the other day I narrowly escaped provoking international complications. I happened to refer to "our pioneer work in this particular sphere of radio activity" and was at once brought up with a round turn and told that radio-activity was purely an American invention which was first publicly demonstrated at Hiroshima.

The latest example of lamentable ignorance occurs in the May, 1951, issue of *Popular Science*. In it we are told that electric shavers and similar interference-producing devices may be taboo in any future war as the enemy might use their radiations as a guide to his bombers or even as "homing" signals to radio-guided missiles. Apparently American scientists have only just woken up to this danger. They are unaware that long before 1939 aircraft radio operators over here knew when they were passing over a large town, no matter how impenetrable the fog, because their 'plane flew into a veritable cloud of interference. By the law of averages, the manipulation of innumerable electric lighting and other switches keeps up a fairly steady stream of interference with radio, and obviously the foggier, the noisier.

I well recollect the Editor of *Wireless World* drawing my attention to this in the early days of the 1939-45 war when the R.A.F. were dropping leaflets over Germany. As a result of his remarks I invented a pilotless pamphlet-carrying 'plane in which the leaflet-dropping mechanism

His ignorance is so profound . . .

was actuated by the radiated interference ascending from the towns and cities over which it flew. The number of pamphlets released each time was strictly in proportion to the strength of the radiated interference, or in other words to the size, and, therefore, the number of inhabitants of each town. Thus paper wastage was avoided. A further advantage was that the 'plane was able to fly well out of the range of fighters and flak without the necessity of pressurised cabins and other expensive adjuncts of a piloted 'plane. The release of the last packet of pamphlets also served to turn the machine's head round for home.

Unfortunately my invention became so enmeshed in red tape that it never took the air.

Legal Loophole

ALL children born in an American embassy—which is technically U.S. territory—automatically become American citizens. Therefore, in the case of the London embassy they dodge the iniquitous purchase tax on their radio requirements, and in the case of cars are entitled also to immediate delivery. Surely this presents a golden opportunity to the staff at Grosvenor Square to help hard-pressed British parents-to-be by opening a combined maternity home and quick delivery service—for cars —in the basement?

CRAFTSMANSHIP

"I can most certainly say at this stage that the workmanship and finish are of a quality which I have never before encountered in the radio industry, despite the fact that my association with the industry in one capacity or another extends back over 27 years. I think you are to be congratulated all the more on this achievement in view of the increasing tendency nowadays towards inferior workmanship and design."

Part of a letter from a purchaser who is a very well-known engineer and whose identity is known to the Editor of "Wireless World."

"POINT ONE" AMPLIFIERS

NEW RC/PA/U REMOTE CONTROL PRE-AMPLIFIER

"POINT ONE" TL/12 12 WATT TRIPLE LOOP FEEDBACK AMPLIFIER

APPLICATIONS

1. For laboratory use as a stabilised-gain audio-frequency power amplifier.
2. For the highest possible standard of disk recording.
3. For the highest possible quality of reproduction from Pickup, Radio, Microphone, Film and Magnetic Tape.
4. For use as a driver amplifier in the speech modulator chain of broadcast transmitters.
5. Used with the RC/PA/U pre-amplifier and the best available complementary equipment the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by *any* equipment at *any* price. It is designed in a form so that the power amplifier can be housed in the base of a cabinet and the small pre-amplifier mounted in a position best suited to the user.
6. The pre-amplifier and the power amplifier are drilled for bolting together to make a single transportable unit. A cover with a carrying handle is available for this unit, and assembled in this form the equipment is particularly suitable for lecturers and for Public Address work where very high quality of reproduction is essential.

The New B.B.C. Monitor loudspeaker uses a Leak TL/12 amplifier. 731 TL/12 amplifiers were ordered by broadcasting authorities during 1950, including :—

The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation.
The Swiss Broadcasting Corporation.
The Italian Broadcasting Corporation.

The "POINT ONE" TL/12 and RC/PA/U AMPLIFIERS are built to a tropical specification and they are distributed throughout the world. During 1951 to date (May, 1951) orders totalling over 2,000 have been received from the U.S.A. for RC/PA/U and TL/12 amplifiers for high quality radio/gramophone reproducers for the home.

FOR COMPLETE DETAILS APPLY TO YOUR LOCAL DEALER OR WRITE TO DEPT. W.

H. J. LEAK & CO. LTD. (Est. 1934)

BRUNEL ROAD · WESTWAY FACTORY ESTATE · ACTON, W.3

Phone : SHEpherds Bush 1173, 1174. Telegrams : Sinusoidal, Ealux, London. Foreign : Sinusoidal, London.

PREMIER RADIO COMPANY

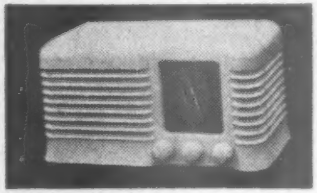
MORRIS & CO. (RADIO) LTD.

BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TODAY'S PRICE

Two modern receiver kits are available. A three-valve, plus rectifier, T.R.F., and a four-valve plus rectifier superhet. Both are housed in attractive Bakelite Cases, size 12in. x 5in. x 6in.
Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. They are for use on 200-250 volt mains, and both A.C. and Universal Models can be supplied.
The Dials are illuminated, and the receivers present an attractive appearance.

T.R.F. Valve line-up :—

EF22 H.F. Pentode.
VR116 Detector.
VT501 Output in the A.C. model.
The A.C./D.C. Output Valve is 12A6. Both use Metal Rectifiers.
Waveband coverage is for the Medium and Long Bands.
Price £5/19/6. (Carriage and packing 2/6) With Walnut or Ivory Cabinet.



SUPERHET Valve line-up :—

6K8, 6K7, 6Q7 and CV1510 Beam Power Output in the A.C. Model.
The A.C./D.C. Output Valve is 12A6. Both use Metal Rectifiers.
Waveband coverage is 16-50, 190-540 and 1,000-2,000 m.
Price £7/19/6. (Carriage and packing 2/6) With Walnut or Ivory Cabinet.

WILLIAMSON AMPLIFIER KIT.

We can supply the Kit of Parts for the latest version of this famous amplifier complete in every detail for **£10/10/-**, with valves, output and mains transformers.

METAL RECTIFIERS.

Bridge type :

2 v. .5 amps.....	2/-	6 v. 1 amp. ...	4/-
12 v. 1 amp. ...	8/-	12 v. 4 amp. ...	17/6

Half wave :

260 v. 30 m/a. ...	4/-	300 v. 75 m/a ...	5/-

E.H.T. Pencil Type :
Output 650 v. 1 m/a., 4/7 each.
1,000 v. 1 m/a., 6/- each
Outputs given are half wave. Two of either Rectifiers can be used in voltage doubling.

P.M. MOVING COIL LOUDSPEAKERS

(3 ohm v/c.)

2½in. Personal Type (15 ohm v/c.)			15/-
3½in. J.P.	9/-	6in. Truvox ...	12/6
5in. Rola	12/6	8in. Plessey ...	14/6

5in. Speaker in handsome plastic cabinet (cream or walnut), 6 × 6in., with v./control, **27/6.**

MOVING COIL LOUDSPEAKERS.

ROLA 6½in. ENERGISED. 1140 ohm field, with pentode O.P. Transformer, 13/- each.

PLESSEY 5in. PERMANENT MAGNET

with extra heavy magnet and pentode O.P. Transformer, 12/6 each.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT.

All parts to construct an eliminator to give an output of 120 volts at 20 m/a. and 2 volts to charge an accumulator. Uses metal rectifier, **35/-.**

MAINS NOISE ELIMINATOR KIT.

Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver, 6/- complete.

GRAMOPHONE AMPLIFIER KIT.

Consists of complete Kit of Parts for a 2½ watt Mains-operated 2-stage Amplifier for use with any type of pick-up. Volume and tone controls are incorporated. Output impedance is 3 ohms.
Cat. No. AMP147. Price complete, 59/6. For 200-250 v. mains with valves and diagrams.

EMI AUTOCHANGER

Plays eight 10in. or 12in. Records (not mixed). Rim drive, mounted on Unit Plate 14in. square for 200-250 volt A.C. mains. Fitted with (Marconi No. 14 P.V.) high fidelity lightweight pick-up with matching Transformer. **£11/10/-**, including Tax.

PLESSEY RIM-DRIVE GRAMOPHONE MOTOR,

mounted on Unit Plate, with auto-stop, 10in. turntable, for 200-250 volt A.C. mains. Fitted with high fidelity magnetic Decca pick-up with sapphire stylus. Last few at **£5/10/-**, including Tax.

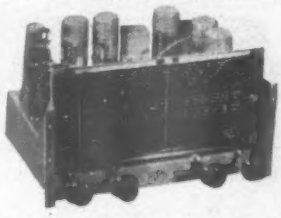
R.107 RECEIVERS

in partly dismantled condition. A wonderful spares investment for R.107 owners, 20/- each. Last Few.

CRYSTAL MICROPHONE.

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound projectors. **Price 22/6.**

NEW A.C. ALL-WAVE SUPERHET KIT.



7 valves (plus rectifiers) for 200-250 v., 40-60 cycles A.C. mains.
4 wavebands, 13.6-52, 51-190, 190-540 and 900-2,100 metres.
Pick-up input. Uses 6K7, 6K8, 6K7, 6B8, 6J5 and two 6V6 in push-pull, giving an output of 10 watts.
Specially designed O.P. transformer to match 6V6's to 3 and 15 ohm speakers.
Negative feedback is applied over 3 stages giving a high fidelity output. Tone control is incorporated, **£16/15/9.**
Also available for A.C./D.C. mains. Specification as above except that valve line-up is 6K7, 6K8, 6K7, 6Q7, 6J7, two KT33C. In Kit form at **£15/17/9.**

WELDING OR GROUND HEATING TRANSFORMERS.

Input 230 v. Output 15 v. 60 amps. Tapped at 14-13.5-13 v. 7½ × 7 × 6in. Weight approx. 50 lb. Price **35/-.** Carriage and packing, 15/-.
We have a limited number with broken terminal boards that we can offer at 35/- plus carriage etc.

SUPER QUALITY TELEVISION MAGNIFYING LENS.

To suit 5in., 6in. or 7in. tubes. Increase picture size considerably, **25/-** each.

T.V. WHITE RUBBER MASKS (CORRECT ASPECT).

We can supply a specially designed White Rubber Mask for 6in. C.R. tubes at 8/6 each.
9in. White Masks, 9/6. 12in. White Masks, 16/11. Round or flat faced.

THERE ARE A FEW TELEVISOR KITS STILL AVAILABLE

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ELECTROSTATIC at £21.0.6

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MORRIS & CO. (RADIO) LTD.

FURTHER BIG REDUCTIONS IN C.R. TUBES AND VALVES

FOR CALLERS

12in. Electrostatic C.R. Tubes perfect for Television. E.H.T. 4/6 KV type CV 956 (NC7)
With white screen **£7 0 0**
With green screen **£5 0 0**

C.R. Tubes—VCR526, VCR967, 2API, CV964. Each **25 0**

Brand New C.R. Tubes at the ridiculous price of **5/-** each. Types available : ACR1, ACR2, ACR2X, ACR8, VCR-1381, ACR19, V1023.

VCR97 C.R. Tubes. Have slight cut-off making them unsuitable for T.V., otherwise perfect. Each **5 0**

9in. Magnetic C.R. Tubes type VCR516. Each **17 6**

12in. Electrostatic C/R Tubes types CV1085, VCR511B, VCR528. Each **17 6**

EMI 4/1 C.R. Tubes 3in. diameter 800 v. Max. Work excellently on 5/600 v. Green screen short persistance.
Each **5 0**
Socket **2 6**

Thermal Delay Switch Valves, type CV190.
Each **3 6**
Per dozen **30 0**

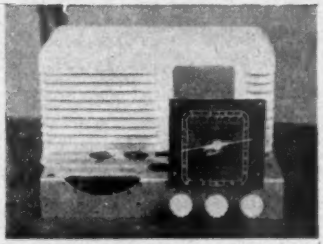
U.H.F. Oscillators type RL18.
Each **5 0**
Per dozen **40 0**

25 watt Pentodes, type PT25H 4 v. 400 v. Each **3 0**
Per dozen **24 0**

VR150/30 Voltage Stabilisers.
Each **8 6**

U.H.F. Triodes, types 7193 and E1148. Each **1 6**
Per dozen **12 0**

Transmitting and Special Purpose Valves 8012, HY114B, 878, 705A, 843, 1625, 1616, 4C27, EL266 (CV15), all Each **5 0**



GIVE YOUR HOME-BUILT RECEIVER THAT PROFESSIONAL LOOK.

We can supply all the parts to help you.
Bakelite Cabinets (Brown or Ivory) 17/6

Punched Chassis
3 valve plus rectifier T.R.F. or 4 valve plus rectifier, Superhet } 5/6

Engraved Glass Dials
16-50 and 180-550 metres
or 180-550 and 800-2,200 m.
or 16-50, 180-550 and 800-2,200 m. } 2/6 each

All with station names, new wavebands.

T.R.F. COILS
180-550, 800-2,200 metres, pair 6/6

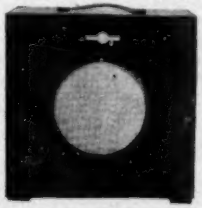
SUPERHET COILS
16-50, 180-550, 800-2,000 metres, set..... 10/6

CORD DRIVE ACCESSORIES FOR ABOVE.

Drum (2½in. diam.)	1/6
Driving Head	1/6
Double Pointer	4d.
Spring	3d.
Nylon Cord (yard)	6d.
Dial Back Plate	2/6

CIRCUIT DIAGRAMS
For T.R.F. or Superhet Receivers, each..... 1/6

PORTABLE L.S. CABINETS
To take 10in. Speaker. Internal measurements 16½in. x 13½in. x 5½in. There is also a small compartment 16½in. x 5½in. x 2½in. at the top for Cables, etc.
This is an ideal Cabinet in which to construct a portable amplifier, and a chassis specially made to fit the Cabinet can be supplied if required



CABINET 18/6
Carriage and Packing 2/6.

CHASSIS to fit size 16½in. x 5½in. x 2in. deep 6/6

1622 Valves (selected) (6L6 Metal). Each ... **12 6**

T.V. Pre-Amplifier for Fringe Reception Areas. We can supply the complete kit of parts to make this wide band width Pre-Amplifier using 2-717A Pentodes. For use with Televisors able to supply 130v. 20 mA., H.T. and 6.3 v., .3 amps. L.T. Completely screened. Includes valves, chassis, diagrams, etc. **32 5**

Separate Power Supply Unit Kit if required (required by both Premier Kits) **24 8**

Please state if the London, Birmingham or Holme Moss model is required

PREMIER MAINS TRANSFORMERS AT LOWER PRICES

SP300A 300-0-300 v., 60 mA. 6.3 v. 2-3 a.; 5 v. 2 a. **19 6**

SP301A 300-0-300 v., 120 mA. 6.3 v. 3-4 a.; 5 v. 2-3 a. **22 6**

SP350A 350-0-350 v. 100 mA. 6.3 v. 2-3 a.; 5 v. 2-3 a. **24 6**

SP352A 350-0-350 v. 150 mA. 6.3 v. 2-3 a.; 6.3 v. 2-3 a.; 5 v. 2-3 a. **32 0**

SP375A 375-0-375 v. 250 mA. 6.3 v. 2-3 a.; 6.3 v. 3-5 a.; 5 v. 2-3 a. **33 6**

Mains Transformers for Williamson Amplifier 425-0-425 v. @ 200 mA.; 6.3 v. 2-3 a.; 6.3 v. 3-5 a.; 5 v. 2-3a. **39 6**

All Primaries tapped for 200-250 volt 50 cycle Mains.

PREMIER TELEVISION CABINET

Well made, Walnut finish.
For 6in. Tube Kit ... **£6 10 0**
For 9in. Tube Kit ... **£7 15 0**
For 12in. Tube Kit... **£9 9 0**
Secure yours now. Supplies are becoming difficult.

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SHEET PAXOLIN

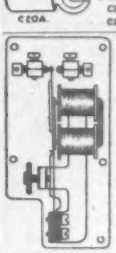
Invaluable for when you are experimenting. Size 6in. × 6in., 1/-. Size 12in. × 8in., 2/-. Size 12in. × 12in., 3/6. Size 24in. × 12in., 6/-.

TOGGLE SWITCHES

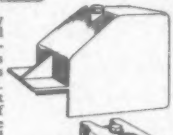
Metal body standard size, made by our leading maker. Available with round dolly or with special V cut dolly. State which type when ordering. Price while stocks last only 1/6 each.

Seven way brass cased plug ideal for portable apparatus. Price 2/3 each half. Bin D33BR & D33BL.

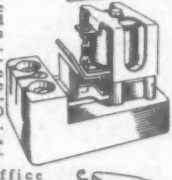
Spades, heavy duty, fit ex-Government car batteries, 9d. each. Bin C20A.



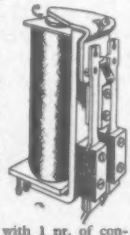
Extra light weight extra sensitive for high speed or radio control work, weight only 1¼ oz., closes on 2 mA., solid, platinum change-over contacts, adjustable pressure. Price 13/6.



Totally enclosed in bakelite, this relay has a 24 v. coil but can of course be rewound for mains operation. Its contacts are suitable for breaking 20 amps. Price, 4/6, 48/- doz.



Post Office types. Upright mounting, prices as follows: sensitive types with coil resistances of 2,000 ohms and over with 1 pr. of contacts 7/6, with 2 pr. of contacts, 9/- then 6d. extra per pair of contacts. Medium sensitivity type 1,000 ohms and over with 1 pr. of contacts, 4/6 extra contact as above. Low voltage types coil resistances of 100 ohms and over with 1 pr. of contacts, 3/6 extra contacts as above.

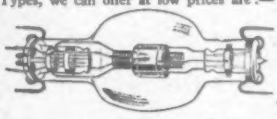


VALVES

We believe that we carry larger stocks than any other firm in Middlesex in consequence we can offer most types of Receiving valves at pre-budget prices, which means a considerable saving of purchase tax. Our stocks are much too assorted to list in these pages, and as prices are controlled, we suggest you order your valve requirements by C.O.D. or send what you think will cover the order, we will refund any extras.

We have never specialised in Transmitting Types, but naturally we stock a few of these, and in most cases, being war surplus, we can give you a considerable reduction on manufacturer's prices. For instance, the one illustrated is a 250-watt Transmitting Triode, heater rating 12 v. 8 amps., it measures 14½in. long and 6½in. across the bulb. It would cost anything up to £20 from the manufacturer, but we have a limited number to offer at 18/6 each.

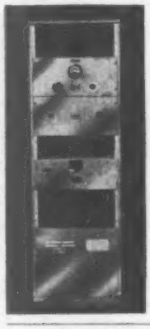
Among other Transmitting Types, we can offer at low prices are:—805 at 27/6, 807 at 12/6, PT15 at 27/6, 1625 at 12/6, 813 at 110/-, 6J6 at 13/6, ML6 at 10/6, 866A at 18/6, TZ40 at 47/6, 35T at 37/6, 860 at 19/6, 872 at 47/6.



"VALVE EQUIVALENTS CHARTS AND STOCK RECORDS"

If your repair Radio Receivers, then you must have a copy of this, for with it you will not only be able to find out the equivalent of an unknown valve, but also you will be able to know if you have one in stock. The stock records system outlined is very simple to operate, but is nevertheless a real time saver. Price of booklet 2/6 post free.

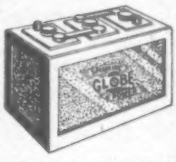
AMPLIFIER RACK



This stands approximately 6ft. high, and was made originally for the G.P.O. The top panel contains the amplifier proper, which consists of an A.C. mains-driven power pack, capable of delivering 200 mA. at 400 v. and, of course, the normal L.T. supplies, and the amplifier itself uses an MHL4 feeder and two PX25's in the output stage, giving approximately 25 watts. This top deck also contains the heavy duty output transformer. The lower panel contains the feeder unit which can be used as a pre-amplifier for microphone and gramophone work. You will observe that on the rack there is ample space for fitting a monitor speaker and an R.F. unit if same are required. Note that the anode current of the PX25 valve is monitored by a 2½in. flush meter. Further note that these amplifiers were made by the famous MARCONI company. Price complete as illustrated but less valves, unused and only very slightly storage soiled, is only £12/10/- each, plus carriage at cost.

6-VOLT AMERICAN HEAVY-DUTY BATTERIES

Made by one or other of the most famous American battery companies. For reliability and long service between charges these are in a class of their own. Capacity rating is 140 amp-hour. We have a limited quantity of these batteries available, unused—in fact they have never been filled with acid, and the price is £5/10/-, carriage extra at cost depending upon your locality.



HEAVY DUTY STARTER SWITCH

This is the type fitted in many older motor cars, made in fact by the famous "O.A.V. Co." This will handle 50 to 100 amps. Few only—2/- each. Bin No. N6AL.

HOT AIR BLOWER

For drying out instruments, etc. This is an attachment which is fitted with a mains operated heating element and heat control, it is designed to fit on a vacuum cleaner tube at the blowing end of course. Price 17/6.

THIS MONTH'S SNIP

Due to a very large purchase, we are able to offer you 8 mfd. 600 v. working electrolytic condensers, aluminium can, upright mounting, made by one of our most famous Companies. These condensers will stand high surge voltages, and the normal list price is 7/- each. All are unused and in perfect working order but outside cases may be soiled. Price only 1/9 each, or 10/- per half-dozen. Order by return because obviously once we have sold these we shan't be able to repeat.

ELECTRICAL INSTALLATION CABLES

In addition to our large range of radio accessories, we also carry a good stock of electrical wiring accessories, details of a few of these and of cables can be found below:—

T.R.S. CABLES, 250 v. CLASS

3/.029 twin flat, 1/4 yd.
3/.029 3-core flat, 2/- yd.
3/.029 twin, with earth, 1/8 yd.
7/.036 twin flat, 2/9 yd.
7/.029 twin flat, 2/- yd.
3/.036 3-core flat, 2/8 yd.
7/.029 twin, with earth, 1/8 yd.
7/.064 twin flat, 4/9 yd.

LEAD COVERED CABLES, 250 v. CLASS

3/.029 3-core, 2/3 yd.
3/.036 3-core, 3/8 yd.
7/.044 twin, 3/3 yd.
3/.036 twin, 2/- yd.
7/.099 twin, 2/9 yd.
7/.064 twin, 5/- yd.

WAR EMERGENCY TYPE CABLES 250 v. CLASS

These are P.V.C. or rubber insulated, laid flat then braided with cotton and compounded:
7/.029 3-core flat, 2/- yd.
7/.044 twin flat, 2/- yd.
7/.064 twin flat, 3/3 yd.

FLEXIBLES

Maroon gauge cotton covered:
23/36 twin twisted, at 6/- doz yds.
P.V.C. 14/36 twin twisted, at 4/- doz. yds.
Twin flat P.V.C. for clocks, etc., 4/6 doz. yds.

MULTICORED FLEXIBLES

All are suitable for mains work as the separate conductors are very well insulated, then they are covered overall either with hard rubber, plastic or waterproofed braiding:—
10 core, at 2/6 per yd.
7 core, at 2/- per yd.
5 core, at 1/- per yd.

CLIX 15 AMP. FOOT SWITCH/PLUG
Made to B.S.S. specification, shuttered in moulded bakelite case, 8/6 each.

15 AMP. PLUG TOP
Good quality 3 pin, will fit the above switch plug. Price 1/9 each.

M.E.M. 10 AMP. SWITCH FUSE
(Memdix), 4/6 each.

"CRABTREE" SURFACE SWITCHES

Lincoln all brown
No. 3000 one way. Price 1/11 each.
Standard 1 way, brown on white No. 3010, 2/6. Standard 1 way double pole, brown on white, No. 3230, 4/-.

700 v. POWER PACK

This is a unit made originally for the Admiralty, Type No. 392. From ordinary A.C. mains, it will deliver 700 v. at 70 mA., rectified and adequately smoothed. Note—these are Admiralty ratings and we have tested the transformer for twice this output over long periods. The filament windings on the transformer are at 4 v., 2.5 amps., and 12.5 v. 1 amp. The Power Pack uses two rectifying valves and is complete in a louvred case. Size 12in. × 15½in. × 8½in. Price 67/6.

15 AMP. DOUBLE POLE ROTARY SWITCH

Made by the famous Diamond H Company, it is complete with pointer knob. Price **5/6**.

EXTENSION SPEAKER IN METAL CABINET

This has a 6½in. P.M. Goodman's Speaker, heavy magnet type, complete with an output transformer. It is fitted in a grey steel case with perforated front and back, ideal for P.A. work in canteens, clubs, etc., **27/6** each.

POWER PACK FOR ALL-DRY RECEIVERS

Output 90 v. H.T. and 7.5 v. L.T. using metal rectifiers. Fitted into bakelite case, size only 3½ × 2½ × 1½, complete with flex and mains input plug. Suitable for A.C. or D.C. mains. Price **19/6**.

REVOLUTION COUNTER

An essential device for coil winding, the type we have count up to 9999. The dial is extra clear and the overall dimensions are 2½in. × 1¼in. × 1½in., **8/6** each.

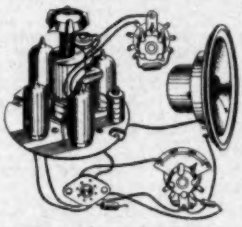
TRIP SWITCHES

In addition to the many industrial uses, these trip switches are useful additions to your laboratory and workshops. Fitted into the power circuit like a normal switch they can in the first place be used to control the power outlets and when as often happens a short circuit occurs, instead of the fuses blowing, the switch will simply trip and will not close again until the short is cleared. The actual current at which the switch trips can be adjusted up to 2 amps. Price **12/6**.

B7G PLUG

With hard rubber body, it fits into standard B7G valve-holder, ideal for joining small chassis. Price **1/4**. (Special terms to bulk users.)

BATTERY PERSONAL CHASSIS



This 4-valve all dry battery-operated receiver is of such small dimensions that it will fit into a cabinet only about 6in. × 4in. × 3in. and still leave ample room for batteries. The chassis is all wired and complete with speaker, volume control, wave-change switch, etc., etc., and only first-grade components have been used. Prices are: Chassis complete with valves (three type 1T4 and one type 3V4)—ready to operate on long and medium wave-bands, **99/6**. Ditto, but medium wave only, **89/6**. Chassis without valves, long and medium wave-bands, **59/6**. Ditto, but medium wave only, **49/6**. Add 2/6 to cover postage and insurance.

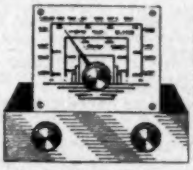
Here is an illustration of the type of cabinet you could make for this set.

RECEIVER 3457

These cost over £100 each to build, they contain 15 valves type EF50 and one each of VR56, VR55, VR92, and 2 of types VR116 and VR54. These contain a host of valuable pot' meters, motors, relays, gear box, and components of all descriptions, and in addition they contain the famous "Pye" 45 Mc/s television strip. Brand new in transit boxes. Price **£5/19/6**.

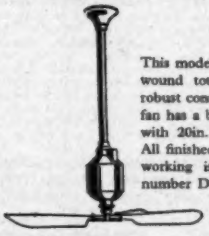
ELECTRON MULTIPLIER

Type 931A. Direct equivalent of the 27M1, can be used for warning systems, locating foreign bodies, burglar alarms, etc., etc. Complete with base and a special light-proof chamber and resistance network. Price **27/6** each.



ALL MAINS CHASSIS

This is the equivalent of a 4-valve receiver for it uses three valves and a metal rectifier. It is all wired up ready to work off A.C. mains, complete with modern valves, ganged tuning, high precision dust-cored coil, first grade condensers and resistors, all on metal chassis. Tunes long and medium wave-bands. Large clear dial. Receives home services; light programme, Luxemburg, etc. Chassis size approximately 9in. × 4in. × 5in. Complete with valves, but less speaker, **50/6**. Suitable speaker with matching transformer, **16/6**—nothing else needed.



CEILING FAN

This model, made by Revo, incorporates a series-wound totally enclosed ball bearing motor of robust construction and noiseless operation. The fan has a blade diameter of 36in. and is supplied with 20in. suspension tube and ceiling canopy. All finished white cellulose enamel. The voltage working is 230-250 v. D.C. Revo catalogue number D12288. Price **£10/10/-**.

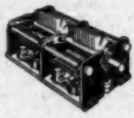
12-CELL ACCUMULATOR

This accumulator can be coupled up to give 24 v. with all cells connected in series or 12, 6 or 2 volts by series parallel arrangements. They were originally made for the Admiralty by a leading manufacturer, have never been filled, and are in excellent condition. Each is contained in a wooden crate as illustrated. Price **27/6** each. Postage and insurance 2/6 extra.

THERMOSTAT

These are sealed in a glass tube and break contact at 31°C. (88°F.). Variations of this operational temperature can be achieved by removing the thermostat, from its glass case and altering the contact screw. No precise figures can be quoted, but we estimate that the limits by adjusting the screw would be from about 20°C. to about 200°C. Price **3/6** each.

TWO GANG 75 pfd. TRIMMER



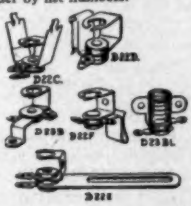
We have an excellent selection of trimmers, air spaced, and mica/compression types. The one illustrated is more than a trimmer, as it can be used to tune many short-wave circuits, it is actually a two-gang 75 p.f. air-spaced variable condenser. The spindle length is approximately ¼in. Price **4/9** each.

INDICATOR LIGHT

Fitted with a coloured glass front and lamp holder. Price **2/3** each.

LAMP HOLDER

We carry a large assortment of dial lamp holders. Price **6d.** each. Order by list numbers.



Orders under £2 add 1/6, under £1 add 1/-. Postable items can be sent C.O.D., additional charge approx. 1/-. Good stock of all items at time of going to press. List 6d. Closed Wed. Aft.—Open all Day Sat.
Telephone: Ruislip 5780

ELECTRONIC PRECISION EQUIPMENT (2) ELECTRON HOUSE, Windmill Hill, RUISLIP MANOR, MIDDX.

GARLAND BROS

QUALTAPE MAGNETIC TAPE RECORDER : the modern, precision-made tape deck, as advertised this journal. Separately-motorised capstan drive, latest design heads. Complete kit of parts, requiring only pliers and screwdriver for assembly, £12/13/0. Send S.A.E. for particulars of our standard and high quality amplifiers, incorporating oscillator, for use with the above and other tape decks.

DECCA THREE-SPEED GRAM MOTORS : for 33⅓, 45 and 78 r.p.m. Instant single-lever speed selection. For A.C. only, 100-250 v. 50 cycle operation. Price (incl. P.T.) £7/3/4. (Please note manufacture of two-speed model now discontinued.)

DECCA TURNOVER PICKUP : a high fidelity crystal pick-up with turnover head (two sapphires) for use on the above or other multi-speed motors. Price (incl. P.T.) £3/19/4.

CHANCERY LONG-PLAYING ATTACHMENT : enables you to use long-playing 33⅓ r.p.m. records on your existing record-player. Easily fitted. Price £3/12/6.

AMPLIFIER 11/46 : an improved version of our Amplifier AC11, for those who desire good quality reproduction at low cost. Valve line-up is 6J5-6J5-KT66-5Z4. Output 5 watts. Volume, tone and variable feedback controls. High grade output transformer. Chassis completely isolated from mains. Complete kit, including punched chassis, all valves and components, with circuits and instructions, £8/2/6. Amplifier wired and tested, £6/2/6.

GERMANIUM DIODES : latest sub-miniature wire-ended glass-enclosed type, by a leading manufacturer. Minimum life 10,000 hours, low shunt capacity, no heater supply required. Special offer at 5/6 each, or £3 per dozen. (We regret we are unable to enter into correspondence in connection with these items.)

METAL RECTIFIERS TYPE RM2 : the latest type rectifier. 125 v. at up to 120 m/a. (depending on temperature). Dimensions : 1⅛in. (diam.)×⅞in. Two of these in series required for mains voltage. Price 4/- each.

VARLEY MAINS TRANSFORMERS : open type, upright mounting. Pri. 10-0-200-220-240 v. Electrostatic screen. Sec. 300-0-300 v. at 150 m/a. 6.3 v. 4 a., 6.3 v. 1 a., 5 v. 3 a. Suitable quality amplifiers or receivers. £2/2/0 each.

BENCH VOLTMETERS : First grade moving iron meters in robust metal case. 0 to 5 volts A.C. or D.C. Separate calibration for A.C. Scale length approx. 6½in. High current consumption, suitable for cell testing, etc. Few only of these brand new meters at 35/- each.

JUNEERO TOOL AND XACTO SLIDE GAUGE : as previously advertised, 27/6 each. Juneero Engraving Tool, for operation on 200-250 v. A.C., 12/6. Juneero Punching and Rivetting Tool, 7/6. All Juneero spares and accessories in stock ; send s.a.e. for price list. Trade and overseas enquiries invited.

HIGH-CAPACITY PRECISION MICA CONDENSERS : by leading manufacturers. Accuracy plus or minus 0.5 (point five) per cent. of stated value. Pure mica and copper foil.

(c)	0.035020 μF 1/6	(d)	0.040710 μF 1/6	(e)	0.055820 μF 1/6
(f)	0.065350 μF 1/6	(h)	0.082910 μF 1/6	(g)	0.087460 μF 1/6
(h)	0.108435 μF 1/9	(i)	0.123750 μF 1/9	(j)	0.147000 μF 1/9
(k)	0.205276 μF 2/-	No further stocks (a), (b) or (b1).			

Many close tolerance standard values may be made up by parallel or other combination of above, e.g., 4k+1+e=1μF ; 2k+g=0.5μF ; c+f=0.1μF. (A table of over 150 series and parallel combinations of these condensers invaluable in calculating filter networks, etc., is available on receipt of 2½d. stamp.)

CONDENSERS (pFs). 2, 4, 10, 15, 20, 25, 50, 75, 100, 160, 200, 6d. each, 5/6 per doz. 220, 300, 330, 500, 1,000, 5,000, 9d. each, 7/6 per doz.

I.F. TRANSFORMERS : 465 k/c., standard size, capacity-tuned. Made for us by a leading manufacturer. Per pair, 12/6.

STABILIVOLTS : Type NSI. Voltage stabiliser and divider. Operating voltages 280 v., 210 v., 140 v., 70 v. ; max. electrode current, 80 m/a. Each 10/-.

STABILIVOLT TYPE VS68. Similar to STV280/40. Operating voltages 280, 210, 140, 70 v. Max. electrode current 60 m/a. A further large purchase enables us to offer these at 7/6 each, or 78/- per doz. while stocks last.

CARBON RESISTORS : Large and comprehensive stocks at following prices : ⅛-watt 4d. ; ¼-watt 5d. ; 1 watt 6d. ; 2 watt 9d. ; 4 watt 1/- each. Among the values available at time of writing are the following : ⅛-watt : 10, 20, 22, 33, 68, 82, 100, 180, 270, 330, 390, 400, 470, 560, 680, 1 k., 1.5 k., 2.2 k., 2.4 k., 2.7 k., 3.3 k., 3.9 k., 4 k., 4.7 k., 5.6 k., 6.8 k., 7.5 k., 8 k., 10 k., 12 k., 15 k., 18 k., 20 k., 22 k., 25 k., 27 k., 30 k., 33 k., 36 k., 40 k., 56 k., 60 k., 62 k., 68 k., 100 k., 270 k., 330 k., 350 k., 390 k., 400 k., 470 k., 680 k., 1 m., 1.2 m., 1.5 m., 2 m., 2.2 m., 4.7 m., 5 m., 6 m.
¼-watt : 30, 43, 47, 100, 150, 160, 300, 400, 450, 470, 500, 1 k., 1.2 k., 2.2 k., 4.7 k., 5.1 k., 6.1 k., 8.2 k., 10 k., 13 k., 15 k., 18 k., 20 k., 22 k., 27 k., 40 k., 50 k., 70 k., 100 k., 600 k., 680 k., 920 k., 1 m., 1.5 m., 2 m., 2.7 m.
1 watt : 50, 56, 68, 82, 100, 120, 180, 220, 2.2 k., 2.3 k., 3 k., 3.9 k., 4.7 k., 6.8 k., 8.2 k., 12 k., 18 k., 20 k., 24 k., 30 k., 55 k., 65 k., 68 k., 70 k., 80 k., 100 k., 330 k., 750 k., 3.3 m.
2 watt : 220, 250, 270, 600, 1 k., 1.5 k., 3 k., 3.3 k., 4.3 k., 4.7 k., 6 k., 10 k., 12 k., 18 k., 22 k., 47 k., 50 k., 68 k.
4 watt : 2.7 k., 56 k., 68 k., 240 k., 470 k.

CRACKED CARBON HIGH STABILITY RESISTORS : 1.5 k. ¼-watt 1%, 4 k., ½-watt 2%, 8 k., 1 w. 2%, 10 k., ½-watt 2%, 40 k., 1 w. 5%, 75 k. ½-w. 5%, 400 k. ½-w. 2%, all at 9d. each.

WIREWOUND RESISTORS : 4 watt : 2Ω, 2.4Ω, 4Ω, 50Ω, 150Ω, 1,000Ω, all at 1/3 each. 10 watt : 170Ω at 1/6. 12/15 watt : 1.5 k., 2.5 k., 3.6 k., 4 k., 10 k., 11 k., 30 k., all at 1/9 each. 25 watt : 4Ω, 350Ω, 717Ω, 5 k., 10 k., 75 k., all at 1/9 each. 45 watt : 14 k. tapped 2 k., at 2/3 each. 65 watt : 50 k. at 2/6. 200 watt : 430Ω, 10 k., 20 k., 50 k., all at 3/- each. We have large stocks of the heavier wattage resistors ; quantity prices on application.

TUNING CONDENSERS : 160 pF. (0.00016μF) maximum. Upright mounting, with four fixing feet, spindle ¼in. diam., length 1½in. Ideal for the short-wave enthusiast. 2/3 each, 24/- per doz., £12 per gross.

CLOSE TOLERANCE SILVER MICA CONDENSERS : 10,000 pF. (0.01μF) plus or minus 2%. Ideal for service bridges, etc. 1/- each, 9/- per doz., £4/10/0 per gross.

PLUGS AND SOCKETS : Pye angle, 1/- ; Pye straight, 1/3 ; B. & L. 5-pin, 1/6 ; B. & L. 7-pin, 1/9 ; Jones 6-way, 1/6 ; Jones 8-way, 1/9 ; Jones 10-way, 2/- ; E.H.T. Single 1/-. The above prices include plug and socket in all cases. Pye T-pieces 9d. Pye connectors, 9d. Now in stock : Pye Angle P. & S. to fit ¼in. cable. 1/3 complete.

PUSH-SWITCHES : type 10F 11062, G.P.O. pattern, D.P.C.O. non-locking, 1/6 each, 15/- per doz., £7 per gross.

CATHODE RAY TUBES : 5CP1, Electrostatic Intensifier-type C.R.T., diameter 5in. max. second anode voltage 2 kv., max. intensifier anode voltage 4 kv., medium persistance screen. Brand new in original crate or carton, 22/6 each.

AERIAL RODS : Copper plated steel. Fit into each other to make up any length aerial. Per doz. 2/- ; per gross 18/- ; per thousand £4/10/0.

POTENTIOMETERS : Unused ex-Govt. Carbon, 3 k., 10 k., 20 k., 50 k., 100 k., 200 k., 500 k., 1 m., each 1/6. Wirewound, 50Ω, 2 k., 5 k., 8 k., 20 k., 25 k., 50 k., each 2/6. 100Ω 1 w. pre-set pots, wirewound, 1/6 each, 15/- per doz. Humdingers, 0-10Ω 1/- each, 9/- per doz.

HEATER TRANSFORMERS : Pri. 230 v., Sec. 6.3 v. 1.5 a., 7/6 ; Pri. 230 v., Sec. 12 v. 1 a. 7/6.

SPEAKER CABINETS : 17in.×17in.×6½in. o.d., 16½in.×13½in.×5½in. i.d., to take 10in. speaker. With carrying handle and separate cable compartment at top. Soundly constructed in wood, these are ideal for dance band use. 10/6 each, carriage and packing 2/6.

BAKELITE-CASED IGNITION SWITCHES : type 5C/547. Will switch substantial currents at low voltage ; many useful applications. 1/3 each, 13/- per dozen, £6/10/0 per gross.

MINIATURE TANDEM POTS. : 30 k., plus 1.5 k. with S.P. switch. Spindle diameter ¼in., spindle length ⅝in. from end of bush. 2/6 each.

VALVEHOLDERS : Ceramic : UX5 (807, etc.), 1/- each, 10/- doz. ; UX7 medium (1625, RK34, etc.), 1/- each, 10/- doz. ; B9G (EF50, etc.), 9d. each, 7/6 doz. Amphenol : Int. Octal, 9d. each, 7/6 doz. ; Br. 7p, 9d. each, 7/6 doz. ; Br.5p, 9d. each, 7/6 doz. ; UX7 med., 9d. each, 7/6 doz. ; UX5 9d. each, 7/6 doz. Paxolin: Br.5, Br.7, UX4, UX5, UX6, UX7, 6d. each.

SPECIAL PURPOSE VALVES : VR65 5/- ; MS/PEN 6/6 ; RL18 5/- ; 7475 5/- ; VR116 5/- ; VT501 (TT11) 6/6 ; EI148 3/6 ; XH15 2/6 ; CV73 4/- ; 9003 5/- ; 954 3/- ; CV1141 6/6 ; CV66 6/6 ; VR136 (EF54) 7/6 ; VR137 (EC52) 7/6 ; VU111 5/- ; VU133 3/6 ; CV54 3/6 ; EI148 3/6.

ACCUMULATORS : 2 v. 10 A/H. In black moulded bakelite case, unfilled and uncharged. 4/9 each.

L. F. CHOKES : 5 H. 100 m/A. 3/6 ; 3 H. 200 m/A. 5/-.

PULLIN MOTORS : type A/3R. For 24 v. D.C. 3¼in. × 2¾in. × 2in. 8/6 each.

METAL CUTTING SHEARS. A robust tool, one-inch blades, will cut up to 16 s.w.g. aluminium. Per pair, 2/- ; per doz. pairs, 21/-, per gross pairs £11/16/0.

SMALL-SIZE PAPER CONDENSERS : 2μF 100 v. wkg., dimensions 1⅛in. × 1¼in. × ⅔in. Ideal for cross-over networks, etc., 4/6 per doz., 45/- per gross ; £14/10/0 per thousand.

MOTORISED SWITCH ASSEMBLY : type 10FB/556. Containing 24 v. miniature motor, 2⅛in. × 1¼in. × 1¼in., gearing, switch contacts, etc. Ex-Govt. Motor only tested. 10/- each.

SLEEVING : 2 mm. oiled silk, etc., 3/6 per 24 nominal yard lengths, assorted colours, 33/- per gross ditto.

METAL-CASED CONDENSERS : 0.01/1,000 v. wkg. 9d. each, 7/6 per doz. 0.1/350 v. wkg. 9d. each, 7/6 per doz. Ditto, but screw-fixing and with long insulated leads, 9d. each, 7/6 per doz.

FOR CALLERS ONLY : Emiscope Type 4/1 3in. Electrostatic C.R. Tube, as used in "Wireless World" Cathode Ray Oscilloscope with Wobbulator (December 1943 issue). Complete with holder, 12/6 each. (Reprints of above article available 7d. each.) **Bomb Computors :** as widely advertised, contain 3 motors, hundreds of gears, aneroids, etc., etc., 39/6 each (bring your car !). **PT25H :** High Output Pentode, 4 v. and 400 v., 5-pin British ceramic base. Also successfully used, strapped as replacement for 4 v. triodes in quality amplifiers. 7/6 for two

ALL GOODS NEW AND UNUSED UNLESS OTHERWISE STATED. GOODS SHOWN AS EX-EQUIPMENT HAVE BEEN FULLY TESTED AND ARE IN GOOD WORKING ORDER. **PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS.** POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY, OPEN ALL DAY SATURDAY.

GARLAND BROS

GARLAND RADIO
CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8
TELEPHONE : TIDEWAY 4412/3

ALLEN & GOULD
5, OBELISK PARADE, LEWISHAM, S.E.13
TELEPHONE : LEE GREEN 4038

UNIVERSITY RADIO

Offer Guaranteed Used Equipment at Attractive Prices

Avo Battery All-wave Signal Generator, as new £10 0 0

Sound Sales 1949 P.M., as new... £5 0 0

Hallicrafters SX16 ..... £21 0 0

Philips Communication Receiver PCR1, with A.C. power pack, as new, in perfect condition £14 0 0

Wilkins & Wright Coil M/C Pick-up, with equaliser, as new £5 0 0

Ernest Turner Fluxmeter, as new, complete £18 10 0

Valradio Convertor, 200/250 v. D.C. 200/50 v. A.C., 300 watts, 75 cycle, works overhauled, as new £11 10 0

Mieco, 30 watt Amplifier, M/C Mike and Gram. inputs, variable output impedance A.C. 200/250, as new £16 10 0

E.D.C. Rotary Convertor, 230 D.C. to 230 A.C., 200 watts, with filter unit and silencing cabinet. Perfect..... £15 0 0

Avo 1948 Signal Generator, as new £12 0 0

Avo Valve Testers, 1948/9, with roller panel, as new £12 0 0

1948 Model Collaro Microgram, complete and in perfect condition, in portable case..... £13 0 0

G.E.C. Miniscope, complete and perfect, as new £12 10 0

Simon Sound Service Recording Amplifier, model EA.25, complete £17 10 0

Ex-W.D. Stab Volt Type 8, stabilised voltage power pack in perfect condition and working order £18 10 0

Brierley Armature Pick-up, with equaliser, as new £7 0 0

WE NEED GOOD USED EQUIPMENT URGENTLY PLEASE SEND, BRING OR PHONE FOR OFFER

Ex-W.D. Mine Detectors, less batteries, in touring case £7 10 0

One Only, Decca non-auto change Decca Deccalion, in perfect condition and working order, as new £21 0 0

Hambander, as new, with speaker £13 0 0

M.C.R.1, complete with coils, power pack, phones etc., as new £8 0 0

Eversheds, 500 volt Wee Megger, in leather case, as new £9 10 0

B.P.L. Signal Generator, A.C. 200/250, as new £10 10 0

Sound Sales 1949 P.M., as new... £5 0 0

Advance E.1 Signal Generator, as new £17 0 0

Mullard R.C. Bridge, as new..... £6 10 0

Taylor 30A'Scope, as new £20 0 0

Taylor 65I3 Signal Generator, as new £12 0 0

Taylor 90A AC/DC Test Meter, as new £9 10 0

Taylor 75A AC/DC Test Meter, as new £9 10 0

Taylor 120A AC/DC Test Meter, as new £7 0 0

Avo Minor AC/DC, as new £7 10 0

Avo Model 7, as new £14 10 0

Avo Model 40, as new..... £12 0 0

Eddystone 640, as new..... £22 0 0

Decca Record Player Unit, Long Playing, as new £9 0 0

Decca Record Player Unit, 3-speed, as new £14 0 0

Goodsell Williamson Amplifier with Goodsell tuner unit as new, cost £53, our price complete..... £40 0 0

Transformer, 110/250 A.C. 2,500 v. at 100 Mills. As new, each..... £5 0 0

WE NEED AR 88's - BC 221's - 348's - 342's ALSO COSSOR DB'SCOPES 339A OR 3339 ETC. WE WILL PAY WITHIN £2.0.0 OF THE MARKET PRICE

Transformer, 230/50 C/I PH. 2 KVA. 30/50/55/60/100/110 volts, 66 amps. at 30 volts, as new £8 10 0

Collaro Record Player, 78 revs. P.M. centre drive, as new..... £8 10 0

Decca Record Player 78 r.p.m., in portable case..... £8 10 0

Garrard R.C.65, record changer, as new £16 10 0

" Presto " U.S.A. Portable Disc Recorder, complete with presto mike, 78 r.p.m., built-in amplifier, can be converted to 33⅓ r.p.m. A.C. 110/250 volts. As new £45 0 0

C.D. Portable Disc Recorder Unit, less amplifier, as new..... £28 10 0

Wharfedale Corner Cabinet Speaker, as new £21 0 0

Vitavox Bitone, as new £30 0 0

L.S.L. Valve Tester and Test Meter, combined, as new..... £9 0 0

R.107, as new £12 0 0

R.108, as new £12 0 0

Ex-W.D. Cossor 'Scope, type 11, single beam, A.C. 200/250. Complete oscilloscope £14 0 0

Pullin Series 100 AC/DC Test Meter, as new £8 10 0

Rees Mace AC/DC 110 Volts/250 6-valve Radio, 30 meg. to 350 kcs., as new. Perfect..... £15 0 0

Eddystone 504, as new £36 0 0

Ex-W.D. A.C. Mains Battery Charger, complete and perfect 3 circuits, 36 volts at 20 amps. each circuit £25 0 0

Ex-W.D. Metal Cases, for Communication Receivers, 22in. x 14¼in. x 10½in., each £2 0 0

R1154, as new £10 0 0

Woden 50 watts Amplifier A.C. 200-250 volts, perfect £18 10 0

B.S.R. Ribbon Mike, as new £7 0 0

Hallicrafters SX28R, complete and perfect, A.C. 110-250 v. ... £21 0 0

THESE ITEMS ARE ONLY A SMALL SELECTION FROM OUR STOCK OF EQUIPMENT. YOUR ENQUIRIES FOR ANYTHING THAT YOU MAY NEED WILL BE WELCOME WE HAVE OTHER EQUIPMENT ARRIVING DAILY!

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The Latest W.B. "Stentorian" P.M. Speakers. 2½in. **15/6**; 3½in., **16/6**; 5in. **17/6**; 6in. **21/-**; 7in. **21/-**; 8in. **24/-**; 9in., **29/6**; 10in. **37/6**.

Potentiometers. New Centralab: 2K, 5K, 10K, 25K, 50K, 100K, ¼, ½, 1 and 2 meg., less switch, **3/9**, with switch, **6/-**. Midget with switch, ½, ¼ and 1 megs. **6/-**. Surplus Midget, 1in. dia. valves between 6 ohm. and 2 meg., **2/6** each.

Surplus Potentiometers. All standard size with extended spindles: 5K, 10K, 15K, 20K, 25K, 50K, 100K, 250K, 500K, 750K, 1 meg., **2/-** each.

Coils. Denco Maxi "Q" High "Q" with miniature size Litz wound on Polystyrene Formers with adjustable Iron Dust Cores. Aerial H.F., or Oscillator for 465 k/c. or 1.6 M/c. Range covers all wavebands from 3.6 to 2,000 metres. Wiring diagram. **Prices**: Chassis Mounting **3/9** (with React. **4/9**). Octal fitting pin base, **4/-** (with React. **5/-**). **Denco** T.R.F. Matched pair Medium and Long Waves, **6/6** pair. Weymouth T.R.F. Matched pair M. and L. Waves, **10/6** pair. Superhet Matched pair S.M. and L. Waves, **9/9** or **11/6** pair. All types Wearite "P" Coils, **2/-** each in stock. Weymouth Midget 1¼in. × ¾in. dia., Iron Core Aerial, H.F. or Osc., **2/9** each.

Electrolytic Condensers. B.E.C. Midget Can Tubular: 8 mfd. 450 v. (1¼in. × 1in. dia.), **3/-**; 8-8 mfd. 450 v. (1¾in. × 1in. dia.), **4/9**; 16-8 mfd. 450 v. (1¾in. × 1in. dia.), **5/6**; 32 mfd. 450 v., **5/6**; 16-16 mfd. 450 v. (1¾in. × 1¼in. dia.), **5/6**. Dubilier "Drillitic" Card Tubular, 4 mfd. 500 v., **3/6**; 8 mfd. 500 v., **4/-**; 16 mfd. 500 v., **5/6**; B.I. Can, standard size, 8 mfd. 500 v., **4/3**; 8-8 mfd. 500 v., **5/9**; 16 mfd. 500 v., **5/3**; 16-16 mfd. 500 v., **6/9**; 32 mfd. 500 v., **6/9**; All New stock. Dubilier mica .001 mfd. 5,000 v., **2/6**.

Denco I.F. Liner for accurately lining-up 465 Kc/s. or 1/6 M/c I.F. channels. Pre-tuned circuits, battery operated and completely self-contained. Price **42/-** (incl. P.T.).

Coil Packs. Osmor Midget Coil Pack. Size 3¼in. × 2¼in. × 1¼in. covering S. M. and L. Waves. Coils wound on Polystyrene Formers with adjustable Iron Cores, ensures efficient performance. Factory wired and aligned. Price including full circuits for Superhet 465 K/c.Unit **49/6** (incl. P.T.). This Osmor Coil Pack is also available for Midget superhet BATTERY Portable sets including a matched ready wound Frame Aerial. Price **55/-** (incl. P.T.). **Weymouth** Midget 2¼ × 2¼in. covering S.M.L. W/Bands, for 465 k/c., employing Matched Iron Cored Coils on each W/Band, **51/6**. **Wearite** Superhet Type 705 and 706 size 4¼in. × 3¼in. × 1¼in., covering two Short Wave and one Medium W/Band or S-M-L Wavebands. 465 k/c., employs Iron Cored Coils. **53/4**. All of the above Coil Packs include Switching, Padding and Trimmer Condensers.

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Output Transformer—Stern's. Midget 1¼in. × ¾in. × 1in. ratio 60-1, **3/9** (or ratio 90-1, **3/9**). Stern's Multi-ratio (over 12 ratios, some C.T.), 5/6 watts, **8/6**. Stern's Heavy-Duty Multi-ratio, all C/Tapped, handles 13 watts and suits P.X.4s, 6L6s, etc., **29/6**. Rola Multi-ratio, 5/6 watts, **13/-**.

L.F. Chokes. Midget 10 henry 250 ohms 40 mA, **3/6**; 20 hny. 250 ohm 60 mA, **6/6**; 20 hny. 300 ohm, 100 mA, **12/9**; 5 hny. 50 ohm 250 mA, **28/6**; 20 hny. 250 ohm 120 mA, **26/-**; 9 hny. 250 ohm, 120 mA, **9/6**; 20 hny. 300 ohm, 120 m/a, **15/-**.

Metal Chassis. Substantially made of gauge 16 B.W.G. with four sides, 7in. × 4in. × 2in., **3/9**; 9in. × 5in. × 2½in., **5/-**; 10in. × 6in. × 2½in., **5/9**; 10in. × 7in. × 2½in. **6/-**; 12in. × 9in. × 2½in., **7/3**; 14in. × 9in. × 2½in., **7/9**; 16in. × 8in. × 2½in., **8/3**; 16in. × 8in. × 3½in., **10/-**.

I.F. Transformer, 465 k/s. New well-known manufacturer's surplus 1in. × 1in. × 1¼in. Iron Core, **9/-** each. Denco Iron Core, 465 k/c. or 1.6 m/c., 1¼in. × 1¼in. × 3¼in., **16/6** pair. Wearite Stand Cap, Tuned, 465 k/c., **30/-** pr. New Surplus 465 k/c. Iron Core, 4in. × 1¼in. sq., **10/-** pair.

Meter Rectifiers. Westinghouse 250 micro/amp., **11/6**; 1 mA, **10/6**; 5 mA, **6/6**.

Selenium Rectifiers. H.T./H. wave. 250 v. 50 mA, **5/6**; 250 v. 100 mA, **7/6**; 250 v. 170 mA, **12/9**.

F. Wave Bridge Rectifiers for Battery Charging or Model 2, 4 or 6 v., 1½ amp., **9/6**; 6 or 12 v. 1½ amp., **11/9**; 6 or 12 v. 3 amps., **21/-**; 6 or 12 v. 6 amps, **35/-**; 12 or 24 v. 3 amps, **23/6**.

Variable Resistor to control charging (or model speed) up to 3 amps. rating, **13/6**. Suitable METER, **5/9**.

Charger Transformers. Suitable for use with preceding Rectifiers. Each has input of 230 volts. Outputs (a) 24 volts tapped 15 v. 9 v. and 4 v. at 3 amps., **23/9**; (b) 30 volts tapped 15 v. and 9 v. at 3 amps., **25/9**; (c) 15 volts tapped 9 v. at 3 amps., **17/9**; (d) 12 volts, 1½ amps, **11/3**; (e) 15 volts tapped 9 v. at 6 amps, **23/-**; 15 volts tapped 9 v. at 1½ amps, **14/3**. 13 volts 1 amp, **7/6**.
A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

NEW SURPLUS !! FOSTER TRANSFORMERS. PRIMARY 230 VOLTS. SECONDARY 12 VOLTS 9 AMPS. 21/-.

Filament Transformer. Inputs 230 volts, outputs 6.3 v. 1½ amp., **8/9**; 4 v. 1½ amp., **7/6**; Input 200/250 v., output 4 v. (C.T.), 1½ amp., 4 v. 2 amp., 6.3 v. 2 amp., **19/6**. Input 230 v. output 6.3 v. (C.T.) 4 amp., **16/6**.

Westinghouse Rectifiers. (a) H.T. 51. Rated 350-0-350 volts, 100 mA, **35/-**; (b) H.T.52. Rated 350-0-350 v., 200 mA, **37/6**; (c) H.T.53. Rated 500-0-500 v., 200 mA, **50/-**; (d) Type 16H.T.56, **17/9**; (e) Type 36E.H.T.25, **11/9**; (f) Type 36E.H.T.35. Rated 2.5 kV, 1 mA, **17/6**; (g) Type 36E.H.T.100. Pulse rating 5/6 kV, **26/6**.

Mains Transformers. All New Stock with Primaries tapped for 200-250 volts. Secondaries (a) 250-0-250 volt, 80 mA, 6.3 v. (tapped 4 v.) 4 amp. and 5 v. (tapped 4 v.) 2 amp., **18/6** (also available with 350-0-350 volt at **18/6**). Stern's 350-0-350 volt, 150 mA, 6.3 v. (tapped 4 v.), 4 amp. and 2 v. (tapped 4 v.) 2 amp., **21/6**; (c) 350-0-350 v. 200 mA, 4 volt, 8 amp., 4 v. 3 amp. 6.3 v. (tapped 2 v.) 2 amp. and 6.3 v. 6 amp., **72/6**, and many to other ratings.

Heater Auto Transformers: (a) tapped 2 v. 4 v., 5 v., and 6.3 volts 3 amp., **9/6**; (b) 4 v. 5 amp. to 6 v. 2 amp. Reversible, **6/6**; (c) 4 v. 3 amp. to 6.3 v. 2 amp. Reversible, **6/6**.

Power Potentiometers. Bulgin adjustable slider type, max. 6 ohms 60 watt, or 14 ohms 60 watt, **13/6** each. Ex-Govt. Rotary Adjustable 50 ohms 60 watt, **5/9**.

A 6-station pre-set Tuner. For Superhet circuits 465 Kc/s. A complete self-contained unit from which any 3 Medium W/band and 1 Long W/band Stations may be pre-selected, and then individually selected by turn of Rotary Switch. No Tuning Condensers required, only 4 connections are necessary, price **47/8**.

Adjustable Mains Droppers. 1¼in. dia. × 2¾in (a) .15 amp., 1,500 ohms, **5/-**; (b) .2 amp., 1,000 ohms **4/3**; (c) .3 amp. 600 ohms, **5/-**.

KITS OF PARTS AND CONSTRUCTORS' ASSEMBLY OUTFITS

A MIDGET 4 STATION "PRE-SET" RECEIVER.

For **1/9** (incl. Post) !! A complete set of Assembly Instructions, showing the COMPLETE CIRCUIT, together with a PRACTICAL COMPONENT LAYOUT and POINT-TO-POINT CONNECTION diagram, for the construction of a 4-station "PRE-SET" SUPERHET RECEIVER, for A.C. Mains 200-240 volts.
This Set is designed to receive three chosen stations on Medium Waveband and one on Long Wave, each station being then selected by the turn of a Rotary Switch, no tuning being necessary. It is of Midget size, being 8½in. × 4½in. × 7in. high, when fully assembled and has the performance of a far more expensive ready-made Receiver, but can be built for about half the price of such a manufactured set.
We can supply the Set either as a complete KIT OF PARTS, or by supplying the Individual Components separately. The complete price details, including an individual COMPONENT PRICE LIST is included with the above Assembly Instruction publication at **1/9**. The detailed instructions and diagrams make the assembly of the Set very simple. An attractive Walnut finished Wood Cabinet is available to accommodate the Set.

A MAINS or BATTERY "PERSONAL" SET

A complete KIT OF PARTS to build our MIDGET 4-VALVE SUPERHET PERSONAL SET, covering MEDIUM and LONG WAVES and designed for MAINS or BATTERY operation is now available.
This 2 Waveband Superhet Receiver is designed to operate on A.C. mains 200/240 volts, or by an "All-Dry" Battery, either method being selected by means of a Rotary Switch. It is so designed that the Mains Section (size 4½in. × 1¾in. × 3½in.) is supplied as a separate unit, which may be added at any time. The latter therefore can be supplied either as an "All-Dry" Battery Personal Set, or as a Midget Receiver for combined Battery/Mains operation.
The circuit incorporates Delayed A.V.C. and Pressicitive Audio Feedback. A Rola 4in. P.M. Speaker with generous size Output Transformer ensures excellent quality reproduction. Ready Wound Frame Aerial, Fully aligned I.F. Transformers, and a Drilled Midget Chassis are included. Valve line-up: 1.R.5 (C.C.) 1 T.4 (I.F. Amp.), 1 S.5 (Diode Det. and Audio Amp.) and 3S.4 (Output Tet.).
We can supply the Set, either as a COMPLETE KIT OF PARTS (with or without the Mains Unit), or by supplying the Components separately. The complete price details, including an INDIVIDUAL COMPONENT PRICE LIST, is included in our Publication on the Set. This publication is available for **1/9** (incl. post), and in addition to the detailed Assembly Instructions it contains, it also shows the COMPLETE CIRCUIT, with a PRACTICAL COMPONENT LAYOUT and POINT-to-POINT CONNECTIONS, which in themselves enable the Set to be quite easily assembled.
An attractive Walnut Finished Cabinet, size 9in. × 5½in. × 5½in., of the hinged-lid type and suitable to house the combined set is available for **21/6**.
A Midget T.R.F. Battery Portable "Personal" Kit. A complete Kit of Parts to build a Midget 4-valve All-dry Battery Personal Set. Consists of Regenerative T.R.F. Circuit employing Flat Tuned Frame Aerial, with Denco Iron Dust Cored Coil, thereby ensuring adequate gain for Single-Tuned Stage covering Medium Waveband.
Valve line-up: 1T4 (R.F. Ampl.), 1T4 (Detector), 1S5 (1st A.F.) and 3S4 (output). Includes latest Rola 3in. Moving Coil Speaker, and a Chassis already drilled and shaped. A consumption of only 7 mA ensures long battery life. The Kit is designed for a cabinet, minimum size 9in. × 6in. × 5in. We can supply the Set either as a COMPLETE KIT OF PARTS, or by supplying the Components separately. The complete price details, including an INDIVIDUAL COMPONENT PRICE LIST is included in our publication on the Set. This publication is available for **9d.** (incl. post), and in addition to the very detailed Assembly Instructions it contains, it also shows the Complete CIRCUIT with a PRACTICAL COMPONENT LAYOUT and POINT-to-POINT connections, which in themselves make the assembly of the Set very simple.

A Complete Kit of Parts to build a **Midget "All-Dry" Battery Eliminator**, giving approx. 69 volts H.T. and 1.4 volts L.T. This Eliminator is suitable for any 4-valve Superhet Personal Set requiring H.T. and L.T. voltages indicated above. The Kit is quite easily and quickly assembled and is housed in a Light Aluminium Case, size 4½in. × 1¾in. × 3¾in. It can therefore be accommodated inside most makes of Personal Sets. Price of complete Kit, **£2/2/6**.

"Wireless World" Midget A.C. Mains 2-valve Receiver. We can supply all the components, including valves and M/coil Speaker to build this set as specified in the March 1950 issue at a total cost of **£3/10/-**. Reprint of detailed assembly instructions and circuit supplied separately for **9d.**

"Wireless World" Midget A.C. Mains 3-Valve Receiver. Covering Long and Medium Wavebands. We can supply all the Components, including Drilled Chassis, Valves, Moving Coil Speaker, etc., to build this Set, as specified in the Feb. 1951 issue at a total cost of **£4/17/9** including a reprint of the complete Assembly Instructions and Circuit (this is available separately for **9d.**) and Practical Components Layout with "point-to-point" connections. An attractive **Walnut Finished Cabinet** is now available for this W/World 3-Valve Set at **21/-**, or it can be supplied with a complete Dial and Drive Assembly which includes the latest Station Name Dial and Dial Escutcheon, and a Combined Switch/Volume Control to effect very slight modification. Inclusive price, **35/-** (Dial and Drive Assembly with Switch/V. Control supplied separately for **14/-**).

We can supply all the Components, including Valves, M/Coil Speaker, etc., to build a **Midget A.C./D.C. Mains T.R.F. 3-Valve (Plus Metal Rectifier) Receiver** as designed and specified by a popular Technical Magazine, at a total cost of **£5/9/6**. A reprint of the assembly instructions, and layout available for **9d.**

An Entirely Complete 3-Valve Amplifier Kit of Parts. Operation on A.C. or D.C. mains 200-250 volts. Has an output of max. 4 watts, with valve line-up 2S.6, 6J7 and U31. A matched 6in. Moving Coil Speaker is supplied. Price, including Wiring Diagrams, **£4/12/6**.

For £6-5-0 !! A complete **KIT OF PARTS** including Drilled Chassis and Valves, to build a **6 to 8 Watt Push-Pull Amplifier**, for operation on A.C. mains. Is suitable for use with Magnetic Crystal or Light-weight Pick-up and incorporates Tone Control. Theoretical and Practical diagrams supplied. Price of Complete Kit, **£5/18/9**. Price of Amplifier Chassis, completely assembled, **£7/10/0**. Circuit and component list separately **9d.**

The **"Summer Allary" Battery Portable** as published in June issue of "Practical Wireless." We can supply from stock all the Components to build this Midget 3 Valve Receiver. The complete Article and Circuit, including Practical Layout and Component Price List, is available for **1/-**.

TELEVISION !! The **"Viewmaster" Televisor**, assembly instructions showing Wiring Diagram and Practical Component Layout available for **5/-**. We have the specified Components, including the T.C.C.—Bulgin—Morganite—W.B.—Westinghouse—Plessey—Colvern, etc., outfits in stock. We can supply this Televisor by the individual stages (as published with the instructions) or by separate Components. Complete price details can be obtained on application.

THE NEW DECCA 2-SPEED GRAM. UNIT. A complete Unit, including Turntable and Pick-up for 33-45 and 78 r.p.m., price **£11/2/8**; or Motor and T/table only, **£7/3/4**; and Pick-up only (for 3 speeds), **£3/19/4.**

★ Send 6d. P.O. for our NEW STOCK LIST, showing many KITS OF PARTS for Sets and Battery Chargers and "hundreds" of Wireless Components. When ordering please include postage and packing.

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CLYDESDALE

Bargains in Ex-Service Radio and Electronic Equipment

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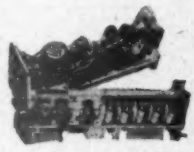
T.V. RECEPTION

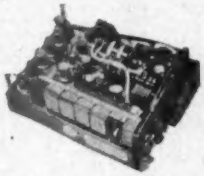
H492. R.A.F. Receiver R.3661. Comprises two individually built chassis, hinged at one end to allow the two sections to be closed together. One chassis comprises an R.F. stage, Mixer and Oscillator, 2/EF50, followed by a 45 Mc/s I.F. strip employing 5 VR65 (SP61's) and an EA50.



The remaining section is built up with the "following" stages of the R.F. deck, EHT and HT power packs (high frequency primary transformer), a 24V. D.C motor and antenna sweep switch assembly, together with various condensers, etc.
The two sections hinge together as one unit and are enclosed in a metal retainer, 18in. × 8in. × 8in. finished in R.A.F. blue.
CLYDESDALE'S PRICE ONLY **£4/12/6** CARRIAGE PAID

BREAKDOWN

R.A.F. E3547 comprises a chassis of remarkable breakdown value and a 24 Volt D.C. reversible motor, 700 : 1 gearbox, sweep switching unit, relays, over 100 various resistors, 50 Mica condensers, 11 potentiometers and numerous various components.



Included in the chassis is a 45 Mc/s I.F. strip employing EF50's and a total of 23 valves, i.e., 15 EF50's, 3 EB34's, 2 EF50's, 2 VR72's, 1 EA50.
Complete unit is housed in a metal box 18in. × 13in. × 7¼in. finished in black.
CLYDESDALE'S PRICE ONLY **£5/19/6** CARRIAGE PAID

INEXPENSIVE TELEVISION

The R.1355 I.F./VIDEO Receiver for T.V. vision or sound, readily available for use on your specific T.V. frequency in that the R.F. is fed in via a removable R.F. unit, i.e. the R.F.24-25-26 or 27. Space for an integral mains power pack is provided by the removal of the existing 80 v/400 cycle pack.
The R.1355 is complete with valves, 5 stages of 7.5 Mc/s I.F. (6F61's) Detector (EA50), Video amplifier (6F61) and Cathode follower (6F61), also an EHT rectifier (6U2150) and H.T. rectifier (5U4G).
Enclosed in a metal case 18in. × 18¼in. × 7¼in.
CLYDESDALE'S PRICE ONLY **67/6** each CARRIAGE PAID
Please include 10/- extra for transit case which will be refunded on return of the case.

UHF/TV RECEPTION

H492. Ex.-R.A.F. 5170 consists of a single deck chassis comprising 2 C.H.F. untuned R.F. stages employing EL37 (CV96) safeguarded by a V1-607 static discharge tube, a variable oscillator stage EL16-EC52 followed by 5 stages of I.F. EF50 (VR91's) with a cathode follower and amplifier employing a further 2 EF50 (VR91) and 2 EA50's as detector and DC restorer stages. A filter stage using an EF50 (VR91) is mounted above the chassis and is stabilized with a CV168.
EHT and HT supplies (high frequency primary) employs a 5Z4 and VU111.
All connectors, plugs, switches, etc., are brought out to the front panel.
The unit is enclosed in a metal box 18in. × 9in. × 8in., finished in grey.
CLYDESDALE'S PRICE ONLY **£4/12/6** CARRIAGE PAID

COMMAND TRANSMITTER CONVERSION

These transmitter chassis are complete except for the inductance windings and valves which were stripped by M.O.S.
All condensers, variable tap coil formers and adjacent components are still intact plus slow motion drives and controls. Original frequency coverage was 5·3 to 7 Mc/s. An excellent basis for compact portable TX or V.F.O. Totally enclosed in a louvred metal cabinet. Detailed conversion ideas available soon.
CLYDESDALE'S PRICE ONLY **12/6** POST PAID

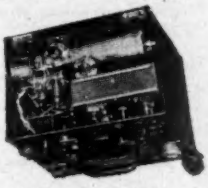
MOBILE U.H.F. ANTENNA

Ex.-R.A.F. U.H.F. Antenna, mounted on a moulded streamlined base into which is fitted an EA50 untuned detector stage.

The antenna measures 22.5 cm. of solid copper construction and all connections are brought out to a 3 pin screened connector at the base of the body.
Dimensions of complete unit: 13in. × 4¼in. × 2¼in.
CLYDESDALE'S PRICE ONLY **12/6** POST PAID

TEST EQUIPMENT

Ex.-U.S. Navy Test Set T824/ARR2 and T824A/ARR2 is a complete oscillator for the alignment of the ZBX aircraft receiver. It produces test signals for both the high and low frequencies of the receiver. The high freq. osc. produces a 245 Mc/s signal, the L.F. osc. can be tuned over a range of 540 to 830 kc/s. **£3/19/6**



The T824A/ARR2 differs from the T824/ARR2 in that it has tone modulation. All valves employed are 935 acorns, and the complete unit is enclosed in a black crackle cabinet with removable top and bottom plates, 9¼in. × 7¼in. × 7in.
CLYDESDALE'S PRICE ONLY **£4/9/6** CARRIAGE PAID

AVAILABLE—BRAND NEW

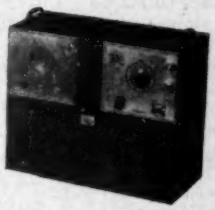
INDICATOR TYPE 6 AND TYPE 6R. These units are mentioned in the INEXPENSIVE TELEVISION design and are complete and brand new, being fitted with a VCR97 Cathode Ray Tube, this tube is probably the most adaptable of all the radar CRT's for T.V. operation. The indicator unit is fitted with 4/VR91 (EF50), 3/VR54 (EB34) plus a host of T.V. components, condensers and potentiometers.
The complete unit is enclosed in a metal box, 18in. × 8¼in. × 7¼in., finished in grey.
CLYDESDALE'S PRICE ONLY **£3/19/6** CARRIAGE PAID
Please include 10/- extra for transit case.

MULTI-WAY CABLE

H.504—YA2736. 5 pairs No. 1 Connector. This is a 10 way braided sheathed cable in 15ft. lengths in new condition.
CLYDESDALE'S PRICE ONLY **5/-** POST PAID

U.H.F. TRANSCEIVER

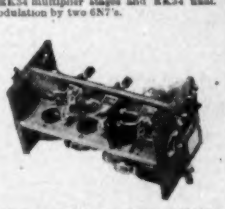
JEFFERSON-TRAVIS U.F.2. This unit consists of a 3valve transceiver chassis, which is complete except for the tuning inductance, and one or two connections to the amplifier valve. The original unit operated on approx. 70 Mc/s.
The transmit/receive side of the unit has been left untouched with all transformers, valveholders and relative components in place but less valves—original valves were 2/6Y7's and 12J5.



The UF2 consists of two units mounted by means of their front panels—one contains the R.F. tuning control, T/R switch and V/Control with all antenna insulation feeding through the panel. The second panel mounts a 3in. P.M. speaker, telephone handset jack and change over switch, both panels are "silver" finished, measuring 6 × 7in.
Complete UF2 is housed in a black crackle cabinet approx. 19¼in. × 10in. × 7in., fitted with handles.
CLYDESDALE'S PRICE ONLY **£2/10/0** CARRIAGE PAID
Circuit details will be available shortly.

V.H.F. TRANSMITTER

H317—85-96 Mc/s Tone transmitter by STRATTON. This transmitter is extremely suitable for "144" modifications and consists of a 6V6 crystal oscillator stage (3 Mc/s plus), RK34 multiplier stages and RK34 final. Speech and modulation by two 6N7's.



The unit is practically complete except for valves—there have been one or two of the inductances removed, but these would need to be replaced in any case for 2 metre operation.
Complete in die-cast mounting with louvred cover 14in. × 8in. × 7in., finished in grey.
CLYDESDALE'S PRICE ONLY **27/6** CARRIAGE PAID
Circuit details will soon be available, also details of a suitable power pack.

V.H.F. RECEIVER

The STRATTON F.40 receiver is the accompanying unit for the H317 transmitter and modifications for 2 metres are also possible. The F.40 covers 85 to 96 Mc/s., crystal controlled oscillator and is complete with valves—1/EF54(RF), 1/EF54 (MIXER), 1/EC52—2/EF54 (OSC. and MULT.), 2/EF39 (IF), 1/EB34(DET/AVC), 1/6J5 1st AUD.) and 1/6V6 (OUTPUT).
The receiver is enclosed in a die-cast frame with louvred cover, 11¼in. × 8¼in. × 4¼in., less crystal.
CLYDESDALE'S PRICE ONLY **£3/19/6** POST PAID

12.25 MCS. I.F. STRIP

H.36A. I.F. Strip by Pye provides a very compact I.F. sub-chassis complete 6F61 valves. The Chassis is wired for IF operation and input leads are tag terminated at rear end of unit. Coax input and output sockets are mounted on the front panel. Dims. 19in. × 5in. × 4¼in.
CLYDESDALE'S PRICE ONLY **47/6** each POST PAID
Chassis, less valves. 17/6 each. Post paid.

FLUXMETER NO. WY 0023

3 range Fluxmeter from 500 to 4,000 units, complete with test coil and instructions for use. Built into wooden case, size 13¼in. × 9in. × 6in. with hinged lid and carrying andle.
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D. COHEN

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MAINS TRANSFORMERS

Primary 200-250 v. P. & P. on each 1/6 extra.
250-0-250, 100 mA., 6 v. 3 amp., 4 v. 3 amp., 4 v. 3 amp., 17/6.
350-0-350, 250 mA. 6 v. 5 amp., 4 v. 3 amp., 32/6.
250-0-250, 60 mA., 6 v. 4 amp. (to be used on common heater chain with 6×5 rectifier), 13/6.
280-0-280, 80 mA., 6 v. 3 amp., 4 v. 2 amp., drop-through, 14/-.
Drop thro, 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.
Semi-shrouded, drop-thro' 280-0-280 6 v. 3 amp., 5 v. 2 amp., 16/-.
Semi-shrouded, drop-thro' or upright mounting 280-0-280 80 mA., 4 v. 6 amp., 4 v. 2 amp., 12/6.
Auto-wound H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp. rectifier winding (upright or drop-thro'), 10/6.
350-0-350 v. 120 mA., 4 v. 6 amp., 4 v. 3 amp., drop-through, 21/-.
Auto-transformer, various combinations of voltages including 110 v. 70 watt, and 3/4 volts windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, 10/6.
Heater Transformers Pri. 200-250 v., 6 v. 1½ amp., 6/-. P. & P., each 9d.

ELECTROLYTIC CONDENSERS

50 mfd. 50 work, 1/9.
100 mfd. 12 v. work, 1/3.
50 mfd. 12 v. work, 1/-.
25 mfd. 25 v. work, 1/2.
16×8 mfd. 450 work, 4/-.
8 mfd. 450 v. work, 2/6.
250 mfd. 12 v. work, 1/3.
16 mfd. 500 v., 4/-.
8 mfd. 500 v., 3/-.
8×8 mfd. 450 work, 3/6.
32 mfd. 350 work, 2/6.
32+32 mfd. small tube tag ends 200 v. work, 2/-.
16+8 mfd. 350 work, miniature tag end, 3/-.

P.M. SPEAKERS

	with trans.	less trans.
3½in.	—	11/6
5in.	15/-	12/6
6½in.	14/6	11/6
8in.	17/-	14/6

5in. Energised 750 ohm field with O.P. trans., 13/6.
P. & P. on each of the above 1/- extra.

THIS MONTH'S OUTSTANDING OFFER

465 Kc. Midget I.Fs. Q. 120, size 1½in. long, 1in. wide, ¾in. deep, by very famous manufacturer. Pre-aligned adjustable iron dust cores, per pair 12/6.

COIL PACK. 3 wave band, 16-50 metres, 180-550 metres, 1,000-2,000 metres. Iron cored coils, I.F. frequency 465 kc. Size 1⅞" high × 3½" wide × 2¾" deep, complete with circuit diagram, tax paid 24/-. Post paid.

WALNUT BAKELITE CABINET. Size 12in. long×7½in. high×6½in. deep, scale aperture 3½in.×4in., louvred front, complete with 3 wave-band scale, back plate, 5-valve superhet chassis and back, 19/6. Post and packing, 2/-.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, 4/9 ; Push-Pull 6 v. 6 matching 10 watt 2 ohms speech coil, 6/9. Miniature type to suit 1S5, 5/-.

SET OF 3 BROWN KNOBS marked "wave change," "tuning," and "volume," 1/6.

MIDGET COMPONENTS. Twin gang ¾in. diameter, ¾in. long. (The dimensions of this gang are slightly deeper than a standard volume control.) Pair Medium and Long iron cored T.R.F. Coils ¾in. long×¾in. wide complete with a 4-valve all dry circuit. Both above items 8/6, post paid.

ALL DRY A.C. MAINS SUPPLY UNIT, size 3½in. long×2½in. wide×1½in. deep. We can supply a complete all-dry circuit, using the above Midget Components to incorporate the above Power Unit, 19/6, post paid with circuit.

MIDGET BAKELITE CABINET. 7in.×5½in.×5in. c/w. 5-valve S/H. chassis med./long wave scale and back (takes std. twin gang condenser and 3½in. speaker), 15/-. P. & P., 1/6.

LINE AND FRAME COIL ASSEMBLY. Frame coils wound but not fitted (full instructions supplied). High impedance frame ; low impedance line, matching 5-1, 8/6.

PRE-ALIGNED MIDGET 465 Kc. Q. 120, 9/- per pair, post 6d.

MINIATURE 465 Kc. I.Fs. Type M400B. 14/-, plus 6d. post and packing.

MINIATURE 465 Kc. I.Fs (slightly larger than the above item). Q.120, per pair, 10/-.

IRON CORED 465 Kc. WHISTLE FILTER, screened, each 2/6.

VALVE HOLDERS. Paxolin International octal, 4d. each. Moulded International octal, 7d. each. EF50 ceramic, 7d. each. Moulded B7G slightly soiled, 6d. each.

LINE CORD. 3-way 0.3 amp., 180 ohm per yard. 1/3 per yard.

CERAMIC P.F.S. 3 each of the following : 330, 220, 180 and 82, 2/6.

TRIMMERS. 5-40 pf., 5d. ; 10-110, 10-250, 10-450 pf., 6d.

TWIN GANG .0005 TUNING CONDENSER, 5/-. With trimmers, 7/6. Post and packing, 6d.

TWIN GANG MIDGET .00037 with perspex dust cover and trimmers, 8/6. Post and packing, 6d.

MAINS DROPPERS. 0.3 amp. 460 ohms, tapped 280 and 410, 1/6 ; 0.2 amp. 717 ohms, tapped at 100 ohms, vitreous, 1/6 ; 0.3 amp. 950 ohms, tapped 700 and 825, 2/6 ; 0.2 amp. 1,000 ohm, vitreous, tapped, 2/6. P. & P. on each, 3d.

VOLUME CONTROLS, by famous manufacturer. Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each ; 20, 25 and 50 k., 3/6 each. Post and packing 3d. each.

VOLUME CONTROLS, by famous manufacturer. Long spindle less switch, 5 k., 50 k., 500 k., 1 meg., 2/6 each. Post and packing, 3d. each.

WAVE CHANGE SWITCHES. 6-pole 3-way, 2/- ; 3-pole 2-way, 1/2 ; 4-pole 3-way, 1/9 ; 5-pole 2-way midget, 1/9. Post and packing, 3d. each.

MINIATURE BUTTON NEON INDICATOR, complete with brass batten holder 200/250 v., 2/-.

MAINS OR BATTERY PORTABLE COILS, comprising medium wave frame aerial and long wave loading coil, used as aerial coils. Midget iron cored screened L/M osc. coils, complete with circuit L.F. frequency 465 Kc., 9/6.

6 IRON CORED LONG MEDIUM AND SHORT WAVE COILS coupling winding on all bands, 13.5-50, 180-550, 1,000-2,000 metres, complete with circuit, 8/6.

METAL RECTIFIER, 250 v. 60 mA., latest midget Selenium type, 7/-.

TELEVISION MASKS

White Rubber. 9in. with glass, 10/6. White Rubber. 12in. with glass, 15/-. 15in. white rubber mask, soiled, 12/6, plus 1/- P. & P.

CONSTRUCTOR'S PARCEL comprising : 5-valve superhet chassis with I.F. trans. and V/H. cut-outs, 13½in.×6in.×2in. with L.M.S. scale 7in.×5in., back plate and two supporting brackets. Drive drum, spindle and pointer, mains trans. G.E.C. 350-0-350 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., and Plessey 8in. H. energised 2,000 ohm field with 5,000 ohm impedance, O.P. trans., 35/-. Post and packing, 2/-.

CONSTRUCTOR'S PARCEL comprising : 5-valve superhet chassis with I.F. trans., and V/H. cut-outs, 13½in.×6in.×2in. with L.M.S. scale 7in.×5in., back plate and two supporting brackets. Drive drum spindle and pointer, 7/6. Post and packing, 1/6.

CONSTRUCTOR'S PARCEL comprising : twin gang with feet, pair long and medium iron cored T.R.F. coils, 4 octal V/H., 3-pole 2-way switch Erie 20k. pot. w/s., heater trans. 220-240 v. 1 amp., 2 yds. flat silk flex, 3 black knobs, chassis 10½in.×5½in.×2in. with speaker and V/H. cut-outs, metal rectifier 60 mA., 230 v. and 32+32 mfd. 200 v., 25/-, post paid.

CONSTRUCTOR'S PARCEL comprising : Chassis 10½×5½in. ×2in. with speaker and valve holder cut-outs, R. and A. 6½in. P.M. with transformer, twin gang with feet, pair medium and long wave iron cored T.R.F. coils. Four International Octal valve holders, wave-change switch and Erie 20k pot with switch, 25/-, plus 1/6 post and packing.

CONSTRUCTOR'S PARCEL comprising : chassis 10½in.× 5½in.×2in. with speaker and valve holder cut-outs ; Rola 5in. P.M. with O.P. trans. ; twin-gang with trimmers ; pair of T.R.F. coils ; Four International Octal valve holders ; wave change switch and Erie 20k pot, with switch, 19/6, plus 1/6 post and packing.

CONSTRUCTOR'S PARCEL comprising : Midget twin-gang with slow-motion drive ; pair midget 465 Kc. I.Fs ; frame aerial ; medium wave osc. coil and layer type H.T. and L.T. batteries 90 v.×1½ v., and midget chassis, 21/-, plus 2/- post and packing.

CONSTRUCTOR'S PARCEL comprising : 5-valve superhet chassis with transformer cut-out, size 13½in.×6in.×2in., with L.M. and S. scale, size 7in.×5in. Back plate, two supporting brackets, drive drum, pointer, two-speed spindle, twin gang condenser. Mains transformer 250-0-250 v. 60 mA., 6 v. 4 amp. Pri. 200-250, 6½in. speaker and 6×5 rect., 35/-, plus 2/- post and packing.

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NEW RADAR PROJECTION INDICATING EQUIPMENT

MODEL V.G. TYPE CG-55 AEB

BRIEF TECHNICAL SPECIFICATION

Power requirements : 115 v. A.C. Single phase, or 230 v. with auxiliary transformer. Total consumption 1,765 watts.
Input requirements : Trigger voltage 5-40 volts peak. Video voltage 3 volts peak max.
Ambient Temperature Limits of Operation : 0°C to + 50°C.
Screen Diameter : 25in.
Picture Diameter : 24in.
Image Visibility : Image on Projection Screen may be observed in the presence of approx. 1 foot-candle of indirect lighting.
Optical System : Highest grade lenses and components by Bausch & Lomb.
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Bearing Accuracy : Within 0.75 degrees.
Overall Dimensions : 59in. x 34in. x 35in.
Weight unpacked : 1,000 lb.

The exceptional quality of construction, together with the numerous operational advantages are several of many features which make this advanced equipment of outstanding interest in the field of Radar Engineering.

Designed and produced by the General Electric Co., U.S.A., for installation in ships, shore stations, aerodromes or research establishments. This Projection Type Plan Position Repeater performs a duty similar to the conventional P.P.I., except that the pattern is optically projected on to a large, flat horizontal surface, instead of being observed directly on a cathode ray tube face. The complete unit is approximately the size of a desk, 35in. high, with the viewing screen occupying half of the top surface, and is operated as a plotting table, on which the actual map-in-motion is portrayed. Navigational calculations are made directly on the paper viewing screen which can be replaced at will from a concealed 30-yard roll supply. The Schmidt Camera and Optical System are of latest design and exceptional quality.

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LASKY'S PRICE **39/6**

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THESE AMPLIFIERS ARE BRAND NEW MANUFACTURER'S SURPLUS, AND NOT EX-GOVERNMENT. Mains working 200-250 volts 50 c.p.s. Supplied complete with brand new Marconi valves, fully guaranteed. Only the highest quality components have been used, and they are comparable with goods at double and treble the price offered. For full data and specifications of the equipment offered send a 2½d. stamp and name and address. (Block letters please.)

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Carriage 12/6 extra.
Outside dimensions of cabinet: 17¼in. × 16¼in. × 32in. high.
Why not convert your table receiver to a console?

COMMUNICATIONS RECEIVER. TYPE P.C.R. By Philips. Perfect condition. Aerial-tested before despatch. 6 valve superhet circuit: R.F., F.C., two I.F.s, D.D.T., pentode output. Frequency coverage: 16-50 mtrs.; 200-550 mtrs.; 800-2,500 mtrs. Fitted in metal case, black crackle finish, with built-in loudspeaker. Flywheel tuning. May be used with any suitable power pack. Supplied complete with 6 brand new Mullard valves. 3 EF39, 1 ECH35, 1 EBC33, 1 EL32.

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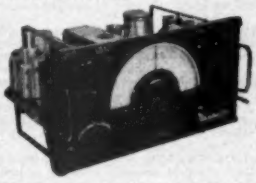

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Carriage (in wood case), 7/6 extra. Full modification data and circuit details supplied.

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Suitable for any type of cathode ray tube. Tetrode **LASKY'S PRICE** **15/-** Postage 1/- extra.
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LASKY'S PRICE **89/6** Carriage 10/- extra.

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Line EHT Trans.	24/6
Focus Ring	22/6
Line width coil	10/-
Boost choke	5/9

TYPE 6 INDICATOR UNIT. BRAND NEW AND UNUSED. IN MAKER'S ORIGINAL CARTON. Contains 1 6in. C.R. tube, type VCR97 and 7 valves: 4 EF50, 3 EB34. Also 12 potentiometers, and hundreds of assorted components, resistances, condensers, etc. In metal case, grey enamelled, size 18in. × 8¼in. × 7¼in. Weight 28lb.

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LASKY'S PRICE **25/-** Carriage 3/6 extra

CONDENSERS. ALL BRAND NEW.

8 mfd. 500 v.w.	3/6
8 mfd. 450 v.w.	3/3
16 mfd. 500 v.w.	4/6
16 × 16 mfd. 450 v.w.	5/6
25 mfd. 25 v.w.	1/11
8 × 16 mfd. 500 v.w.	5/6
60 × 100 mfd. 350 v.w.	8/6
64 mfd. 500 v.w.	6/6

Postage extra.

CAR RADIO PLUG SUPPRESSORS. Brand new Ex-Govt. Normally listed at 1/6 each.

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WHY NOT CONVERT YOUR 9in. TELEVISION RECEIVER TO A 12in.? With a Westinghouse Boost E.H.T. Kit. Contains 1 36EHT40, one 2 meg resistance, and 2 TCC. .001mfd 6Kv condensers.

LASKY'S PRICE **30/-** Plus 1/- postage.

T.V. SCAN COILS FOR LINE AND FRAME. Brand new, manufacturer's surplus. For 9in. or 12in. c.r. tubes.

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12 volts 6 amps., 27/6, post 9d. extra.
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AT OUR LIVERPOOL AIRPORT STORE. 450 brand new Sperry Artificial Horizons. Navigators Indicators 1-82A. Pilot Indicators 1D/103/APN3, Visual Indicators 10Q/13003, Bomb Release Gear No. 1. Mk. 1. 11A/2029 Mk. 3. 11A/2837 Warning Lamps 5c/1556, Cockpit Lamps 5c/1494, Spark Plugs LS86/87, Aircraft Generators 5U/562, Alternators 5U/1271, Black & Decker Aircraft Loadometers, etc. We have an interesting collection of aircraft equipment which commercial buyers will find well worth inspection. Quotations and/or appointments without delay.

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EX. AIR MINISTRY COMMUNICATION RECEIVER TYPE R1155. Brand New in Wood Transit Cases. Aerial Tested before despatch. Supplied Complete with 10 valves and reprint of "Wireless World" 5-page Data describing easy conversion for Civilian use. Ranges 18.5–7.5 mcs, 7.5–3 mcs, 1500–600 kvs, 500–200 kcs, 200-75 kcs. Suitable power pack described below. OUR PRICE £10/10/-. Carriage per passenger train, 7/6.

1155 POWER PACK AND OUTPUT STAGE (U50 and KT61) to "Wireless World" Specification. Neat black crackle case size 12 x 8 x 5, with 5in. LS Built in. Connections terminate in a Jones plug which simply plugs into your 1155 and set is instantly all AC operated without any modifications. Specially made by us and match in appearance with 1155. Has rubber feet and stands on top of set. PRICE £6/10/-, plus 3/6 carriage. (Delivery 14–21 days.)

12-VOLT CAR RADIO. Comprises a type 455 Receiver expertly modified by us and fitted with volume control for immediate operation from car battery. Tunes medium waveband. Has a remarkable performance. Power is obtained from the dynamotor incorporated which is very quiet in operation. Dimensions are 11in. long, 4¾in. wide, 5¼in. deep. No aerial is supplied but any car aerial will suit. (Not available for 6 volts). Exceptional value at £6/10/-, carr. paid.

TELEVISION PRE AMPLIFIER. This Ex-Govt. one valve preamplifier is of very high sensitivity and makes an amazing improvement in vision and sound reception in fringe areas. Very small dimensions. Length 4in., width 3¼in., overall depth to top of valve 4¼in. Fitted with EF50 valve. Co-ax. input and output sockets. Ideal for any TV receiver which can supply 6.3 v. LT and 200/275 v. HT. 3 connections only to power supply. HT common and LT. Diagram of connections included. Guaranteed. Type "A" for London, Type "B" for Birmingham. PRICE 15/-, plus post 1/-.

PAMPHONIC PA LOUDSPEAKERS. Brand New in Makers Packing. 10in. high flux unit. Handsome maroon cellulose cabinet. (Metal). 20in. x 9in. x 13in. Impedance 3 ohms. Supply of these is very limited. Less than half price, 55/-, carr. paid.

TYPE 87 ROTARY POWER UNITS. Input 24 v. Output 250 v. 65 ma. and 6.6 v. 2.5 a. Elaborately smoothed. Neat black metal case. Size 8½ x 7 x 4½. Brand new 10/- each. Post 1/6.

AMPLIFIER A1271. Brand new in sealed cartons. Size 5 x 5 x 5in. Fitted VR56 DPDT Relay, 2 mfd. condenser, Potmeter, 2 transformers, neat case. Unique value, 15/- each, post 1/6. (90 only).

BC456B 40 WATT MODULATOR UNIT. Fitted with 1625 (same as 807 with 12 v. heater). 1215 Triode and VT150 Neon stabiliser. 3 Supersensitive relays. Modulation transformer. Driver transformer. Output transformer. High quality resistors and condensers. Brand New, 30/-. Carr. 1/6.

CAY TUNING UNITS TYPE 47181A. 800–1500 kcs. Brand New in metal case with lid. 3 slow motion dials, four switches and many other fine parts. 15/- or without case 10/-, carr. 2/6.

AMERICAN THROAT MICROPHONES. Vibration sensitive carbon. Two moulded phenolic units with soft cotton covered elastic neck band. Total weight 2½ oz. Brand new in cartons. 5/- per set. Post 6d.

CONTROL UNIT 454A. Brand new in sealed packing. Size 8½ x 6½ x 3½. Fitted with 0–1 ma. meter. 450 k. pots, 1 5 k. pot, 1 250 k. pot, 1 DP Toggle switch, 3 jewel light jacks, 1 G.P.O. type 2 pole switch, 1 Yaxley 5 pole switch. Ideal for conversion to a first class test meter. 38 only. PRICE 30/- each. Post 1/6.

SELECTOR DRIVE IMPULSE RELAY, with ratchet mechanism. 1 notch per impulse. Type No. 10D/373. Brand New in sealed cartons. 3/9, post 10d.

VOLTAGE CONTROL UNIT. Type C3. Brand new in original cases. On/Off switch, Pilot light, 6 bank fuse panel 5 mfd. 3 mfd. Heavy Duty Mains Noise Suppressor. Excellent case. Ideal for amplifier. Outstanding value 12/6, post 1/6.

FREQUENCY METERS AMERICAN 906D. Brand new in transit cases. 150–225 mcs. Black Crackle Cabinet. Absorption type. Vernier drive dial. Midget telescopic antenna. Precision microammeter 0-500 indicates resonance. Power requirements 1.5 v. LT 45 v. HT. Has phone jack, 2 toggle switches. Valve fitted type VT172. Complete with calibration chart and circuit. PRICE 4 gns., carr. 5/-.

SECTIONAL AERIAL MASTS. 10 sections each 3 feet. Metal sleeved sections, seasoned timber. Fitted with Guy Hooks. Store soiled but absolutely sound. Price 50/- each, carr. 5/-. Few doz. only.

AIR MINISTRY 10A/14381 MICROPHONE. Brand New. Looks like a small headphone earpiece. Fitted with switch and short lead terminating in a 2-pin socket. Low impedance. Unique bargain. 2/6 each, post 6d.

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SUMMER SPECIALS

R.1155 COMMUNICATIONS RECEIVER. The famous ex-R.A.F. Bomber Command set. Covers 5 wave ranges, 18.5-7.5 mcs., 7.5-3.0 mcs., 1,500-600 kcs., 500-200 kcs., 200-75 kcs., and is easily and simply modified for normal mains use, full details being supplied. These sets have had some use, but are all guaranteed tested and working before despatch, and are offered at ONLY £7/19/6 (carriage and packing 10/-). A factory-made power pack with output stage, which operates the R1155 immediately, can be supplied for £5/5/-, or with a built-in speaker, £6.

INDICATOR UNIT, TYPE 6. The very popular indicator unit which is recommended for so many uses, and in particular for conversion to the "Wireless World General Purpose Oscilloscope." Contains a 6in. C.R. Tube type VCR 97, 4 valves EF50, and 3 of EB34. BRAND NEW IN MAKERS CRATES. ONLY 79/6 (carriage 7/6). Constructional data as above supplied free with each unit, or available 9d. The following components required for the conversion are also available. EHT TRANSFORMER for VCR 97 32/6 (postage 1/6), 4 v. EHT RECTIFIER with ceramic base 8/6 (post 9d.) 20n 80 ma. CHOKES 6/6 (post 9d.).

"PYE" 45 MCS. I.F. STRIP. Ready made for the London vision channel, this 5 stage strip contains 6 valves EF50 and 1 EA50. Circuits and simple mod data supplied. BRAND NEW. ONLY 60/- (postage, etc., 2/6). Less valves 37/6 (plus postage 2/6).

10 VALVE 1½ METRE SUPERHET ZC.8931. The ideal receiver for long distance TV results. The valve line-up is 6 of VR65, 2 of VR92, and 1 each VR136 and VR137, and the 12 mcs. 6 stage I.F. Strip gives tremendous amplification with ample bandwidth of 4 mcs. Easily modified, full details being supplied. BRAND NEW IN MAKERS CARTONS. ONLY 39/6 (carriage 5/-).

19t I.F. STRIP. Another strip easily modified for TV. Contains 6 valves VR65, and 1 each VR53 and VR92. This 6 stage strip measures only 18in. x 5in. x 5in. and is particularly recommended for constructors who have built televisors but are having trouble in the vision or sound receivers. Full modification data supplied. BRAND NEW. ONLY 45/- (postage, etc., 2/6).

OSMOR MIDGET COIL PACK TYPE H.O. Covers S.M. and L. waves, and is complete with full circuits for 465 kcs. superhet unit. Limited quantity only available at pre-budget P.T. rates. ONLY 40/4 (postage 8d.).

3in. VITAVOX P.M. SPEAKER. A really beautiful job, incorporating an aluminium cone which gives better response and volume. IN SEALED MAKERS CARTONS. ONLY 11/9 (postage 9d.).

MUIRHEAD 3in. SLOW MOTION DRIVE. A really precision product with edge marked 0-180. Complete with cursor, in makers cartons. BRAND NEW. ONLY 8/6 (postage 10d.).

TELESCOPIC AERIALS, extending from 15in. to 102in. Just pulls out of steel tube. Very strong. BRAND NEW. ONLY 12/6 (postage 10d.).

SECTIONAL TELESCOPIC AERIAL, comprising 16 sections each 16in. in length, and colour coded for easy assembly. Complete in web case. BRAND NEW. ONLY 9/6 (postage 10d.). 100/1,000 kcs.

DUAL CRYSTAL. As used in the Class D Wavemeter. BRAND NEW IN MAKERS CARTONS. ONLY 25/- (post paid).

WALKIE-TALKIE CHASSIS TYPE 38. This beautifully made 6-valve chassis is offered as a summer "snip." Ideal for the enthusiast. As used by the Forces, with the exception of certain transmitting parts and crystals removed by the Ministry of Supply (no valves). ONLY 9/6 (postage 1/6).

Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only.

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DECCA TWIN-SPEED RECORD PLAYERS. 78 & 33⅓ r.p.m. Type 37a

Fully Guaranteed.

£12.1.6

Manufactured by the pioneers of long-playing technique on a commercial scale in this country, the Decca 37A Twin-Speed Player gives the user facilities for playing both Long-Playing and Standard records on the same machine.
The turntable is mounted on a heavy, pressed-steel base and the change-over from 78 to 33⅓ r.p.m. is accomplished by a simple but positive lever movement.
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A compact and reliable unit, the 37A player gives not only first-class reproduction, but first-class value for money. Carriage paid.

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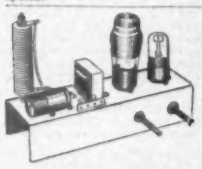
This small induction motor is specially designed for magnetic tape and wire recorders. Absolutely silent in operation and virtually free from vibration. Minimum stray magnetic field for A.C. mains 100-250 v. 50 cycles.

38/- Post free



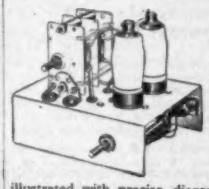
AC/DC AMPLIFIER, Type A2

The amplifier type A2 is based on the same fundamental design as its successful predecessor, the A1, but while the A1 can be used only on A.C. mains, the A2 may be used on A.C. or D.C. The A2 is introduced to meet the demands of those who are on D.C. To those on A.C. the A1 is to be preferred since the safety factor is so much higher.
Owing to the use of a transformer-less power supply the A2 amplifier is offered at a price which is extremely competitive, and places good equipment in a price range so far unheard of.
All the components which form the A2 amplifier are tested and of first grade. Moreover each kit is fully guaranteed.
The kit is supplied complete in every detail right down to nuts, bolts, solder tags, and solder. A pre-drilled chassis is supplied. A comprehensive instruction manual gives the fullest construction details, the instructions being written in such a way that those without previous knowledge can construct the A2 amplifier with the sure knowledge that it will operate, without trouble, from the time of first switching on. The instructions are supplemented with many clear diagrams. The circuit is simple and straightforward, but by the careful choice of component values the performance is outstanding. Primarily designed for crystal pick-ups, the amplifier can be used with magnetic pick-ups if desired. Output 2.5 to 3 watts.
Complete kit with valves for A.C./D.C. mains. Instruction manual only 3/- **65/-**

AMPLIFIER A1, For A.C. 200-250 v. only.

Kit, incl. valves, for gramophone amplifier giving high quality reproduction. Simple instructions with many illustrations enable even those without previous experience to construct this amplifier. Kit complete in every detail down to solder tags and solder. Pre-drilled chassis, group board with all resistors, condensers, etc.
Complete kit with instruction manual **92/6**
Instruction manual only 3/6. Tone control kit 5/-

M·O·S "EASY-TO-BUILD" Series RADIO FEEDER - Type RF1.



Designed for use with A.C. operated amplifiers, the Radio Feeder RF1 employs a two stage T.R.F. circuit giving a high quality output. By the use of high-gain pentode valves, sensitivity is such that the unit can be operated in areas of only moderate signal strength. Like all M.O.S. kits, the instructions are simple to follow, the instruction manual being liberally illustrated with precise diagrams. The kit itself is complete in every detail from a pre-drilled chassis, valves, coils, etc., to nuts and bolts and solder.
Instruction Manual (containing full details) **2/-**
RF1 Feeder Unit Kit with Manual **52/6**

NEW FULL VISION DRIVE ASSEMBLY

Vertical dial with new station markings on S., M. and L. wave bands (3 colours). Size of dial approx. 5in. by 7in. in "Perspex" with back illumination plate. Drive mechanism absolutely positive and non-slip, with nylon cord. Complete with assembly instructions.
Post free **21/-**

MINIATURE SPORTS BINOCULARS

A pair of small binoculars with magnification x5. Finished in pastel plastic. Extra lightweight. Plus 6d. postage and packing. **14/6**

R.1355 RECEIVERS

Complete with valves. Just the job for the T.V. receiver, employing a VCR 97 tube. The complete receiver can be made on the chassis with very little alteration and the power unit can also be accommodated. 5 stages of I.F. amplification at 7 mc. 8, SP61's, 1, 5U4G, 1, VU120. Host of resistors and condensers.
ONLY **52/6** BRAND NEW.

Press Button Soldering! The "BURGOYNE" Seven Second SOLDER GUN

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Here's the tool every home handyman has always wanted. This amazing new tool saves electricity bills. Makes soldering child's play. No current used unless actually making a joint; cold when not in use; no element to burn out; heat up in 7 seconds; no risk from touching the "wrong end." No constant retinning. Ideal for Handyman or radio enthusiast. A.C. only 200-250 v.
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ACOS. GP20 MICROCELL PICK-UP

Extremely low needle pressure—13 grams—and a flexible stylus mounting, virtually eliminating record wear. The GP20 has a rising bass characteristic which enables it to be used without equalisers. The crystal element is non-hygroscopic and unbreakable. We recommend this pick-up as first choice for use with the A1 amplifier **£3.11.5**

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Our previous offer of *Mine Detectors* is renewed, as we have just secured a further small quantity of these metal locating equipments, store soiled.

Full circuits available separately, 2/6 per manual. Equipment: 3-valve battery-operated amplifier in steel case, a shoulder haversack, two search coils with poles, junction boxes, headphones, 2 spare valves, circuit diagrams, log book, connecting cables and sensitivity measuring stick, operating instructions. Packed in transit case. In view of the huge demand expected no correspondence can be exchanged concerning this offer.

BARGAIN PRICE OF 22/6

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NO. 38 "WALKIE-TALKIE" TRANS./RECEIVER. Complete with throat mike, 'phones, junction box and aerial rods in canvas bag. Freq. range 7.4 to 9 mc/s. All units are new and tested before despatch. As supplied to Overseas Police Forces. £4/19/6, carriage 2/6.

PLESSEY, 3in. P.M. SPEAKER with miniature Output Trans. 17/6. W.B. 2½in. P.M. 3 ohms, less trans., 15/-.

VR91 (EF50) RED SYLVANIAN. Brand new and boxed, 10/-. Brand new (British), 8/6. Ex-Units (but guaranteed), 6/-.

GERMANIUM CRYSTAL DIODES, complete with full wiring circuit and diagram, 4/6.

METAL RECTIFIERS. S.T.C. 200 volts, 75 m/a., 6/- ; G.E.C. 6 volts. 1 amp., 4/- ; Westinghouse 12 volts, 2 amp., 12/6 ; Pencil Type E.H.T. 600 v. 1 m/a., 4/7 ; Pencil Type E.H.T. 1,000 v. 1 m/a., 6/- ; Pencil Type E.H.T., 2,400 v. 3 m/a., 15/- ; Pencil Type 350, 500 v., 2 m/a., 7/6.

5M/A METER RECT., 6/- ; W.6 and WX6, 1/6.

5 CPI. C.R. TUBES. Brand new and boxed, 25/-. Carr. paid.

FILAMENT TRANSFORMERS. All inputs 200/50 A.C. 6.3 v. 1.5 amp., 7/6 ; 6.3 v. 2½ amp. 10/- ; 6 v. or 12 v. 3 a., 15/- ; 6.3 v. 12 a., 37/6.

R.3515 I.F. STRIP. A complete I.F. Unit, comprising 6 SP61 I.F. Stages, tuned to 13.5 mc/s., 1 EA50 diode detector, and 1 EF35 or EF39 output or video stage. A few modifications only are required to adapt this unit, which will give pictures of extremely good quality. Price, complete with valves, and foolproof modification instructions, is 45/-, plus 5/- carriage and packing. Limited quantity only.

R3547 RECEIVERS. Absolutely brand new, in sealed manufacturers' packing cases. Incorporating 15 valves type EF50, 2 of SP61, EF36, EBC33, 3 of EB34. Complete 45 mc/s. I.F. Strip, motor dial and drive, pots, etc., etc. £6 only, plus 10/- packing and carriage. Whilst they last !

EX-R.A.F. INDICATOR UNIT TYPE 62. Containing VCR 97 CRT with mu-metal screen : Xtal Unit and valves 16/VR65 (SP61), 2/VR54 (EB34), 2/VR92 (EA50), etc., etc., two deck chassis in metal case. 18 x 10½ x 11¼in. New condition. 67/6 each. Plus 7/6 packing.

INDICATOR TYPE 6. These units are brand new, in excellent condition, and are all fitted with a VCR97 CRT, the tube which many constructors have put to T.V. use. Valves include 4/VR91 (EF50), 3/VR54 (EB34), plus a host of potentiometers and H.V condensers, etc. The complete unit is enclosed in a metal box 18 x 8½ x 7½in. **PRICE ONLY £3/19/6,** POST PAID. Please include 10/- for transit case to ensure safe transit of unit. Refunded on return of case.

RECEIVER TYPE 21. The receiver portion of the W/S 21 operating from 4.2-7.5 mc/s. Double superhet from 18-30 mc/s. Incorporating B.F.O. and crash limiter. Valve line-up 7-ARP12 (VP23) and 2-AR8 (HL23DD). Absolutely brand new, complete with circuit. Only 45/- complete. Vibrator Power Unit for above, brand new, 17/6 only.

RECEIVER R.1355, as specified for "Inexpensive Television." Complete with 8 valves VR65, and 1 ea. 5U4G, VU120, VR92, and a copy of "Inexpensive T.V." ONLY 55/- (carriage, etc., 7/6).

FREQUENCY CONTROL CRYSTALS. By American G.E. Co. Octal base fixing. Following frequencies only : 2,500 kc/s., 3,500 kc/s., 4,600 kc/s., 6,200 kc/s., 8,000 kc/s., 7/6 each. Also FT243 ½in. pin spacing, 5765KC/7975, 10/-each. 8000/8425KC, 12/6. New and unused.

MIDGET .0005 mfd. TWO GANG TUNING CONDENSERS. Size only 2½in. x 1¾in. x 1½in. Capacity guaranteed, standard length ¼in. spindle, complete with mounting bracket, less trimmers, 6/6 or, complete with "built-in" trimmers, 7/6 each plus 6d. post.

VIBRATOR POWER UNITS, 2 volt. As for Canadian 58 set. Completely smoothed, output 1.5 v. L.T. and 90 v. and 180 v. H.T. at 35 m/a. Complete in grey metal box. Size 8 x 3½ x 4½in. 50/- only.

TYPE 25 R.F. UNIT, brand new, converted from new R.F.24. 19/6. (Carriage and packing 1/6.)

R.F. UNIT TYPE 24. For 26-30 mc/s. Preset, switched tuning, incorporating 3 valves SP61. Brand new, ONLY 16/6. This unit can now also be supplied modified to cover R.F. 26 frequency (for Midlands T.V.), brand new, at 25/-.

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COMMUNICATIONS RECEIVER TYPE R1155. *A first rate superhet communications receiver already known to most short wave enthusiasts home and overseas. As an introduction, may we suggest the new revised and enlarged "Wireless World" leaflet which gives circuit data and all relevant information. The price is 1/3d post paid. At £7.19.6, the R1155 represents outstanding value and as supplies are becoming very scarce you are advised to buy NOW ! Although not new at this price they are nevertheless in excellent condition and air-tested before despatch. There is a carriage charge of 10/- to cover despatch in maker's original transit case. We will gladly demonstrate any receiver to personal callers.*

R1155 Power Pack/Output Stage. Enables the receiver to be operated direct from A.C. mains. Just plug in and connect low impedance speaker. (Note : speaker NOT supplied). Only £3/19/6.

Receiver R3547 Contains 15 of EF50, one of VR36 (EF36), one of VR55 (EBC33), two of VR116, three of VR54 (EB34), one of VR92 (EA50), and a 45 Mc/s. "Pye" Strip. Also included are 11 pot'meters, a motor with gear box, relays and numerous other small components all mounted on an extremely useful chassis. BRAND NEW IN TRANSIT BOXES. Only £5/19/6, carriage paid.

45 Mc/s "Pye" Strip. A ready made vision receiver (London frequency). Uses six of EF50 and an EA50. Complete circuit data provided. Less valves, 35/- ; with all valves, 57/6, plus 1/6 postage. In brand new condition.

Receiver Type 21. A battery operated superhet receiver covering 4.2-7.5 Mc/s. and 19-31 Mc/s. Operates as a double superhet on the 10-metre band. Complete with nine 2 v. valves and circuit diagram. New condition. 45/-, carriage paid.

6 v. Vibrator Pack. Suitable for use with the 21 set. Output 150 v. at 40 m/a. fully smoothed and rectified. Circuit diagram included. Only 17/6, post paid.

Command Receiver Type BC453. Frequency range 6-9 Mc/s. Valve line-up : three of 12SK7, one of 12K8, one of 12SR7, one of 12A6—all metal valves ! I.F. value 1415 kc/s. In brand new condition and complete with circuit diagram. Contained in a black crackle case, 55/- post paid. A bargain.

Simpson Dual-range Ohmmeter. BRAND NEW AMERICAN INSTRUMENT. Incorporates 2½in. moving coil meter. Ranges : 0-2,000 ohms and 0-200,000 ohms. 52/6, post free.

Portable Testing Instruments. These Multimeters are perfect, brand new and contained in manufacturer's original box. The instrument is a moving coil volt-ohm-milliameter, complete in an attractive carrying case with handle. The dial is calibrated for readings of 0.1-5 v., 0-3 v., 0-60 m/a. and 0-5,000 ohms. Further ranges may be added as desired. A range switch is also incorporated and the basic movement is 6 m/a. 250 ohms resistance. Our price : 15/-, plus 1/6 post/packing.

COMPONENT MART

24 v. Extractor Fans. For operation from 24 v. A.C./D.C. but will function from mains when fitted with a suitable dropper resistance. Has many uses—ventilation purposes, as a hair dryer, etc. AS NEW. Only 12/6, plus 1/6 post/packing.

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Mains Transformers. Standard primaries, universal mounting. 350-0-350 v. 80 m/a., 0-4-6.3 v. 4 a. and 0-4-5 v. 2 a. ; 250-0-250 v. 80 m/a., 0-4-6.3 v. 5 a. and 0-4-5 v. 2 a. ; 30 v. 2 a. tapped 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., and 24 v. All these transformers are brand new, fully guaranteed and priced at 18/6, each plus 9d. post.

E.H.T. Transformers. For VCR97 or VCR517 tubes. 2,000 v. 4 v. for tube heater and 4 v. tapped at 2 v. for E.H.T. rectifier. Brand new and fully guaranteed. Our price 35/-, plus 9d. post.

Metal Rectifiers. 12 v. 2 a. full wave bridge, 12/6, plus 6d. post. Miniature H.T. rectifier type RM2, 125 v. 100 m/a., 4/3 each, or 2 for 8/-, plus 6d post one or two.

Potentiometers. Heavy duty twin wire wound pot., 10 K and 100 K., 3/- each, post free.

Speakers. 3in. P.M., brand new, 11/9, plus 9d. post. 6½in. P.M. with heavy duty magnet, 9/6. Callers only this item.

Coil Pack. 3 waveband, short, medium, long, complete with all trimmers, padders, switch, etc., ready for use. Employs slug tuned iron cored coils throughout. With circuit diagram, 17/6 each, plus 1/- post/packing.

Electrolytic Condensers. 8 mfd. 600 v. wkg., 700 v. surge, three for 10/-, post paid. 16 mfd. 500 v. wkg., 600 v. surge, three for 11/6, post paid. These condensers are tall can type single hole fixing. Minimum quantity supplied by post is three.

Multiple Block Condenser. Electrolytic. 8 × 16 × 4 × 4 × 6 mfd., all for 450 v. wkg., 4/9, each plus 9d. post or two for 10/-, post paid.

Block Condensers. Electrolytic. 8 mfd. 500 v. wkg. Three for 9/- post paid.

See if you can pay us a visit during July. Many, many bargains for the personal caller this month. Our usual range of valves, tubes, components and specialised equipment on display at keen prices.

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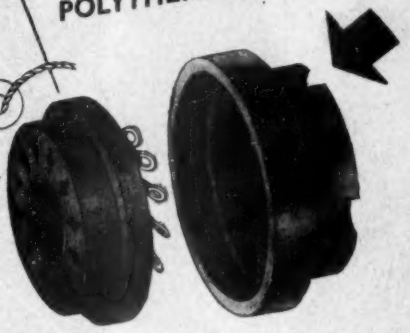

B12A— Duodecal

FOR CATHODE RAY TUBES

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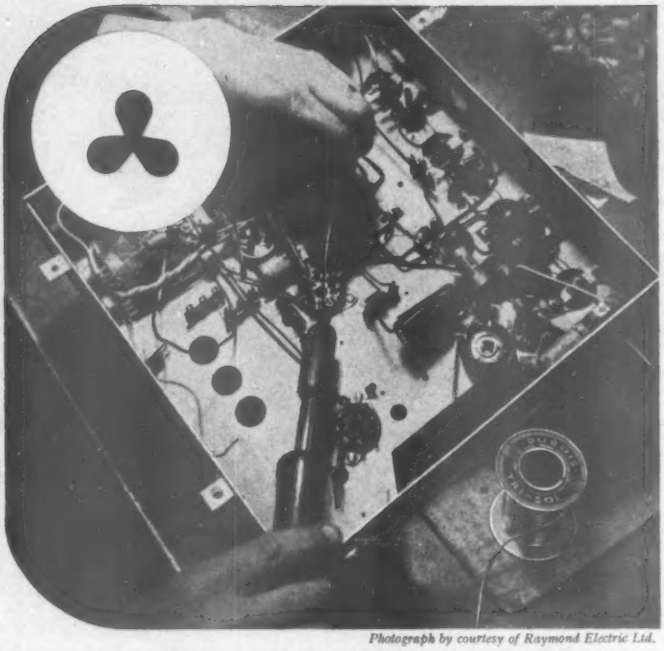

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The other half has now been completed and we are busy printing the supplement, which is even bigger than the original issue. We hope to have this ready for distribution to existing subscribers by the middle of July, and their catalogues will then be complete up to 1951. Present subscribers need not write to us; we have all their names properly filed.

But to those who have not yet acquired a copy of this quite essential guide to the world's best records we want to explain what it is. It is not an encyclopaedia of everything; such already exist and others, no doubt, will come. It is exactly what it calls itself—a *selected* record catalogue, including all the records we could find which were well performed and well recorded. Apart from a few minor composers, the whole world of recorded music has been most carefully explored, and the records have been listened to on real high-fidelity equipment.

The form is a loose-leaf binder, and the sheets are supplied ready punched and properly arranged. As further supplements come out (as they will for a very modest charge) they can be filed in proper order, so that the whole story, forever growing, is in one cover. The catalogue naturally takes its place on any bookshelf. And you do not have to scrap it because of a new edition.

In addition to the record lists there are sections dealing with the choice of records, the choice of equipment, and sound technical information on reproducing L.P. records so that their full beauty can be enjoyed in the home.

PRICE 25s. COMPLETE.

We can offer it at this very small cost because we bought the loose-leaf binders three years ago. Bought today (if they could be obtained at all) the cost would be very much higher. This being so we have to announce that the edition is very strictly limited, and when our present stock of binders and paper is exhausted we shall not be able to accept further orders for possibly a year.

The high cost of records makes it vital that you do not buy the wrong ones. However carefully you may listen to records in the shop, your final judgment can only be formed after listening at leisure at home. If the Selected Record Catalogue saves you from buying only one wrong recording of a symphony, it will have earned its cost straight away. But it will *always* save you from buying the wrong record. Where could you get a better insurance policy for a premium of only 25s. ?

Send your order as quickly as possible for distribution during July. If you prefer it we will send what has already appeared at once and post the supplement later when we distribute to our old subscribers.

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BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C.; any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0122

ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.

DIESEL Electric generating plants, 3kva., 230v with push-button remote control, starting equipment ready for use, £205.

ROTARY transformers, input 20v d.c., outputs 6.5v d.c. and 300v d.c., permanent magnet field, 20/-; ditto, input 28v d.c. and 1,200v 75ma d.c. output; energised field, 35/-; ditto, input 12v d.c., output 500v, 90ma d.c., energised fields, 35/-.

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DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

FOR sale as new, rotary convertor by E.D.C.C., 24v D.C. in and 240v A.C. out at 625 amps; £12.—Auto & General Electrical Services (Inverness), Ltd., Millburn Rd., Inverness. [6983

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DIESEL alternator, 230/1/50, 3kva, belt-driven by Petters, very latest type diesel engine, A.V.1 self-energised, automatic voltage control, press-button and remote control started, 1, press-button start and stop control unit supplied; complete with H. duty Exide starter battery with charger for starter battery; full load 4¼-5 hrs. on 1 gall. of cheap fuel; engine covered by Petters' inspection service; plant tested on full load before dispatch, delivered ready for use; £210.

J.A.P. No. 2a engine, 1.2hp, 4-stroke, air cooled, complete with few tools and inst. book and spares list, latest type engine; £15.

THE above two items are not surplus, but latest products of British manufacture.

REGRET no other items this month, due to being behind with existing orders and large number of enquiries, which are receiving earliest attention; so please, only for July, limit enquiries to the above two items; see displayed advert, page 88, for S.T.C. selenium rectifiers; terms, c.w.o., pro-forma invoice; c.o.d. (post goods only).

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B.S.R. MU-10 gram motors, 2-speed, turnover pulley for 33 or 78 rpm, £3/15.

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ALL above prices include purchase tax; post free in United Kingdom.

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RADIOGRAM chassis, 10-valve, 10-2,000 metres; £25.

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OUTPUT Transformers—split primary and secondary, level to 0.3db, heavily made, impregnated, 70/-, 47/6, and 21/- (all 3 and 15ohms to 8,000).

CASTING Clad, quality Vortexion transformers, to order good delivery. June issue, AF valve voltmeter, cabinet, transformers and other parts. Trade supplied.

BEL, Manufacturing Engrs., Marlborough Yard, London Archway, N.19. Arc 5078. [0187

TAPE recorder motors, 230v a.c., powerful, quiet, brand new, 15/11; post, etc., 1/1.—K. W. Logan Westalley, Hitchin, Herts. [6469

CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment, price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7, for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.

PLEASE write for details to K.T.S., Ltd., 60, Aylward Rd., London, S.W.20. (Liberty 3436.) Callers by apointment only. [6724

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The reason is clear,
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MAGNETIC TAPE

Recording Equipments and Components

OSCILLATOR UNIT. Constructed on small chassis, suitable for sub-assembly, provides r.f. for erase and bias at 45 kc/s. Requires 250 v. h.t. and 6.3 v. for operation. Complete with 6V6 valve, £3.

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TAPE. New high coercive force tape suitable for high fidelity recording at slow speeds. 7in. (1,200ft.) reels, £1/10/-. Spare reels, 7in., 4/6 each. 11in. (1,000 metre) reels also available.

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TRANSFORMER. As above, but fitted in 16 S.W.G. mumetal screening can, 30/-. Send for further details including circuits.

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Valve line-up: EF36 Low level input.
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6J5 Phase splitter.
2 6V6 Push-pull output.
5Z4 Rectifier.
Incorporating negative feed back 2, or 15Ω outputs. Provision for feeder unit. Complete in chassis 13in. × 9in. × 3½in. Wired and tested. Price **£13/17/6**, carriage 2/6.

A.D.S. 4½-WATT AMPLIFIER.
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EF36 Amplifier with tone control.
6V6 Output.
5Z4 Rectifier.
Incorporating negative feed back 3 or 15Ω output. Provision for feeder unit. Complete in black crackle cabinet. Price **£9/17/6**, carriage 1/6.

A.D.S. MEDIUM WAVE RADIO FEEDER UNIT. EF36 R.F. amplifier. EF36 triode connected detector. This unit is ideal for quality reproduction of local transmissions. Power required: 250 v. 10 mA, 6.3 v. 0.5 amps. Complete in black crackle cabinet. Price **£6/12/6**, carriage 1/6.

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EF39 I.F. amplifier.
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P. Type, 4 ratios	8/-
G.P.8, 8 ratios	12/6
Universal, 8 ratios	11/-
W.12, 3 ratios	23/6
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A LUXURY receiver, can be built within £45, includes CRT, drilled chassis, coils, transformers all special parts. Full parts list available.
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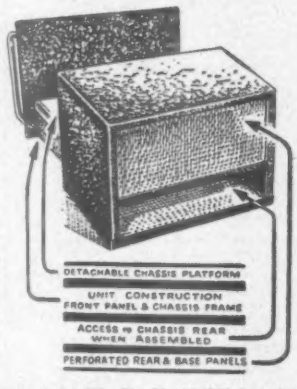
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F315.	350-0-350 v. 160 m/a., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	43/9
***F350.**	350-0-350 v. 90 m/a.	22/3
***F250.**	250-0-250 v. 110 m/a.	24/11
***F300.**	300-0-300 v. 110 m/a.	25/11
***F360.**	350-0-350 v. 110 m/a.	27/11
Above marked * L.T.s 0-4-6.3 v. 4 a., 0-4-5 v. 2 a.		
W.F.2.	300-0-300 v. 70 m/a.	15/3
W.F.3.	350-0-350 v. 70 m/a.	17/6
Above 3 L.T.s 6.3 v. 2 a., 5 v. 2 a.		
W.F.4.	350-0-350 v. 80 m/a.	19/11
W.F.5.	260-0-260 v. 90 m/a.	19/11
W.F.6.	350-0-350 v. 90 m/a.	20/11
Above 3 L.T.s 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 2 a.		
S3515.	350-0-350 v. 150 m/a., 6.3 v. 4 a. C.T., 5 v. 3 a.	29/3
F3515.	350-0-350 v. 150 m/a., 6.3 v. 4 a. C.T., 5 v. 3 a.	32/9
S205.	250-0-250 100 m/a., 6.3 v. 6 a., 5 v. 3 a.	27/9
F205.	250-0-250, 100 m/a., 6.3 v. 6 a., 5 v. 3 a.	29/11
Williamsons mains F.625.	425-0-425 v. 200 m/a., 6.3 v. 4 a. C.T., 6.3 v. 4 a. C.T. 5 v. 3 a.	52/11
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C.K.9.	10 H. 150 m/a.	29/11
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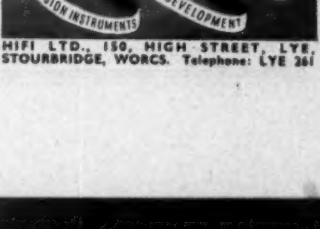

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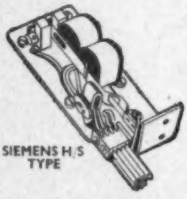

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INDEX TO ADVERTISERS

	PAGE
A.A. Tools	100
Acoustical Mfg. Co., Ltd.	7
Adcola Products, Ltd.	103
Aerialite, Ltd.	4
Alfa Precise Instrument Co.	98
Allan, Richard, Radio, Ltd.	54
Ambassador Radio	24
Anders Radio, Ltd.	82
Antiference, Ltd.	43
Armstrong Wireless & Television Co., Ltd.	91
Arrow Sales, Inc.	95
Ashworth, H.	47
Ateliers de Constructions Electriques de Charleroi (Belgium)	28
Audigraph, Ltd.	100
Audix, S. B., Ltd.	46
Automat.c Coil Winder & Electrical Equipt. Co., Ltd., The	1
Automatic Telephone & Electric Co., Ltd.	19
A.W.F. Radio Products	101
B. & H. Radio	100
Bakers "Selhurst" Radio	32
Barker, A. C.	91
Belling & Lee, Ltd.	55
Birmingham Sound Reproducers, Ltd. 24,	50
Bradmatic, Ltd.	48
Brierley, J. H. (Gramophone & Recordings), Ltd.	48
Britain, Chas. (Radio), Ltd.	78
British Communications Corpn., Ltd.	40
British Distributing Co.	90
British Institute of Engineering Technology	93, 96
British National Radio School	93
British Physical Laboratories	45, 80
Brookes Crystals, Ltd.	100
Brown, S. G., Ltd.	32
Buchan, A. E.	99
Bulgin, A. F., & Co., Ltd. Ed t. 299,	82
Bull, J., & Co., Ltd.	87
Bullers, Ltd.	41
Cabot Radio Co., Ltd.	84
Candler System Co.	96
Champion Products	88
Chapman, C. T. (Reproducers), Ltd.	82
Cinema-Television, Ltd.	13
Clayton-Wright, Howard, Ltd.	100
Clydesdale Supply Co., Ltd.	71
Cohen, D.	72
Cosmocord, Ltd.	54
Davis, Alec, Supplies, Ltd. 85,	101
Davis, Jack (Relays), Ltd.	102
Day, Will, Ltd.	90
Donchoe's (Timers)	96
Drayton Regulator & Instrument Co., Ltd.	26
Du Bois Co., Ltd., The	80
Duke & Co.	95
Dupley Electronics, Ltd.	92
Edison Swan Electric Co., Ltd.	9
Electradix Radios	90
Electro Acoustic Developments	101
Electro Technical Assemblies	30
Electronic Instruments, Ltd.	38
Electronic Precision Equipment 66,	67
Electronic Service (Hallamshire), Ltd.	18
E.M.G. Handmade Gramophones, Ltd.	88
E.M.I. Institutes 40,	44
Erie Resistor, Ltd.	29
Erskine Laboratories, Ltd.	48
Eta Tool Co. (Leicester), Ltd.	16
Farmer, John	87
Fluxite, Ltd.	84
Frith Radiocraft, Ltd.	20
Furzehill Laboratories, Ltd.	32
Galpins	85
Garland Bros.	68
Garrard Engineering & Mfg. Co., Ltd., The	2
General Electric Co., Ltd. 23,	38
Glaser, L.	100
Goldberg Advtg. Pty., Ltd.	61
Goodmans Industries, Ltd.	49
Goodsell, Ltd.	43
Grampian Reproducers., Ltd.	44
Gray, Arthur, Ltd.	28
Hall Electric, Ltd.	81
Hallam, Sleigh & Cheston, Ltd.	36
Hartley, H. A., Co., Ltd.	84
Hayes Co., The	90
Haynes Radio, Ltd.	96
Henley's, W. T., Telegraph Works Co., Ltd.	96
Henry's	78
Hifi, Ltd.	97
Holle, Arthur	94
Holley's Radio Stores	98
Homelab Instruments	56
H.P. Radio Services, Ltd.	76
Hunt, A. H., Ltd.	14
Imhof, Alfred, Ltd.	30
Industrial Electronics	14
International Correspondence School, Ltd.	22
Jackson Bros. (London), Ltd.	47
Lasky's Radio 74,	75
Lawrences Liverpool, Ltd.	73
Leak, H. J., & Co., Ltd.	63
Lewis Radio Co.	92
Lockwood & Co.	98
London Central Radio Stores	39
London Radio Supply Co.	37
Lowther Mfg. Co.	41
Lyons, Claude, Ltd.	82
Lyons Radio	92
Mail Order Supply Co.	77
Marconi Instruments, Ltd.	97
Marconi's Wireless Telegraph Co., Ltd.	60
McElroy-Adams Mfg. Group, Ltd.	42
McMurdo Instruments Co., Ltd. 6,	79
Measuring Instruments (Pullin), Ltd.	46
Metalectrix	86
Metro Pex, Ltd.	100
Metropolitan-Vickers Electrical Co., Ltd.	27
Midland Instrument Co.	87
Modern Book Co.	96
Modern Electrics, Ltd.	94
M.R. Supplies, Ltd.	18
Mullard, Ltd. 3, 10,	52
Multicore Solders, Ltd. Cover	iv
Murex, Ltd.	12
Mycalex, Ltd.	20
New Electronic Supplies Co.	88
Newman, J. & S., Ltd.	101
Northern Radio Services	93
Northern Transformer Co.	93
N.S.F., Ltd.	18
Nusound Products	95
Oak Electric Co.	97
Olympic Radio Components	92
Osmor Radio Products, Ltd.	22
Painton & Co., Ltd.	45
Park Radio Ltd.	46
Parmeko, Ltd.	4
Partridge Transformers, Ltd.	83
P.C.A. Radio	82
Pearce, T. W.	72
Pennine Amplifiers	99
Philips Electrical, Ltd.	79
Pitman, Sir Isaac, & Sons, Ltd.	97
Polytechnic, The	100
Post Radio Supplies	94
Pratts Radio	101
Premier Radio Co. 64,	65
Quality Mart	99
Quartz Crystal Co., Ltd.	90
Radio Exchange Co.	89
Radio Industry Council, The	6
Radio Mail Order Co.	95
Radio Servicing Co.	90
Radio Supply Co.	81
Radiomenders, Ltd.	100
Radiospares, Ltd.	100
Rainbow Radio Mfg. Co., Ltd.	98
R.C. Radio-Electric, Ltd.	96
Reliance Mfg. Co. (Southwark), Ltd.	99
Reproducers & Amplifiers, Ltd.	21
Robinson, F. C., & Partners, Ltd.	8
Robshaw Bros., Ltd.	44
Roding Laboratories	26
Rogers Development Co.	22
Rola Celestion, Ltd.	60
Rollet, H., & Co., Ltd.	92
Royal Air Force, The	11
Salford Electrical Instruments, Ltd.	16
Samsons Surplus Stores	92
Sangamo Weston, Ltd.	37
Savage Transformers, Ltd.	96
Scharf, Erwin	38
Scientific Acoustics, Ltd.	99
Sifam Electrical Instrument Co., Ltd.	80
Simon Sound Service Cover	ii
Smith, H. L., & Co., Ltd.	94
Smith, G. W. (Radio), Ltd.	89
Sound Rentals, Ltd.	51
Sound Sales, Ltd.	62
Southern Radio Supply, Ltd.	94
Spencer West	98
Sphere Radio, Ltd.	40
Stability Radio Components, Ltd.	10
Standard Telephones & Cables, Ltd. 5, 53,	56
Steatite & Porcelain Products, Ltd.	17
Stern Radio, Ltd.	70
Sugden, A. R., & Co. (Engineers), Ltd.	28
Supacolls	97
Szymanski, S.	18
Taylor Electrical Instruments, Ltd.	98
Taylor, Tunnicliff (Refractories), Ltd.	25
Telecraft, Ltd. 8,	94
Telegraph Condenser Co., Ltd. Cover	iii
Telegraph Construction & Maintenance Co., Ltd., The	49
Tele-Radio (1943), Ltd.	74
Thermionic Products, Ltd.	24
Transradio, Ltd.	30
Trix Electrical Co., Ltd. Edit.	297
Ultra Electric, Ltd.	12
United Insulator Co., Ltd.	36
Universal Electrical Instruments Corpn.	76
University Radio, Ltd.	69
Valradio, Ltd.	34
Venner Accumulators, Ltd.	58
V.E.S. Wholesale Services, Ltd.	101
Vitavox, Ltd.	2
Voigt Patents, Ltd.	99
Vortexion, Ltd.	59
Walton's Wireless Stores	96
Wayne Kerr Laboratories, Ltd., The	42
Westinghouse Brake & Signal Co., Ltd.	34
Weymouth Radio Mfg. Co., Ltd., The	42
Wharfedale Wireless Works 36,	42
Whiteley Electrical Radio Co., Ltd.	62
Wilco Electronics	86
Wilkinson, L.	100
Wright & Weaire, Ltd.	33
Young C. H.	80

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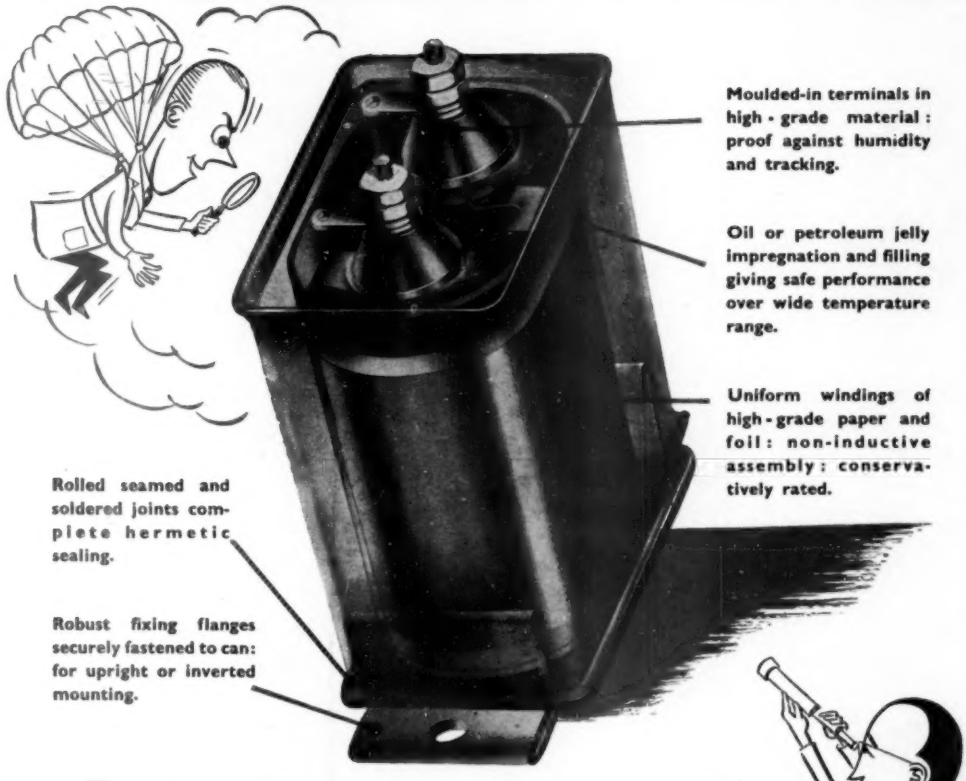

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